External sewage system
ASG ESTERNO

CONTENT

FIELD OF APPLICATION

Pipes and fittings of external sewage systems ASG Esterno is intended for the transportation of sewage without pressure at a temperature of up to 60°C. Short-term supply of wastewater is allowed with a temperature of up to 95°C (no more than 1 minute)

DESCRIPTION OF THE SYSTEM

ASG Esterno is a reliable and high-quality solution for the construction of external sewage systems.

The use of **PVC-U** brand polyvinyl chloride for the manufacture of pipes and shaped parts guarantees the following properties such as high strength, corrosion resistance and wear resistance. The system has smooth internal surfaces,which prevents fouling and has a low weight. **ASG Esterno** meets all modern standards for external sewage systems. Production and control of pipes are carried out in accordance with **National Standards of Ukraine B V.2.5- 32:2007** and **DIN EN 13476-2**. Fittings are also manufactured and tested in accordance with **National Standards of Ukraine B V.2.5- 32:2007** and **DIN EN 140.**

Production is subject to careful quality control at all stages of production, including the inputcontrol of raw materials, extrusion parameters, surface quality, dimensions and marking, packaging.

Each batch of pipes and fittings is tested in the factory laboratory in accordance with **National Standards of Ukraine** to confirm the quality and conformity of the production technology

MATERIALS AND TECHNICAL PARAMETERS

Pipes and fittings are made of high-quality polyvinyl chloride brand **PVC-U**, presented in two classes of ring stiffness: SN-4 (4 kN/m^2) and SN-8 (8 kN/m^2). The PVC ensure complete tightness, which prevents interaction with soil and groundwater. Their lightness, convenience in transportation, arrangement and operation are additional advantages. The design of the sockets gives pipes and fittings increased rigidity and reliability. The main characteristics of PVC-U brand polyvinyl chloride are presented in the table.

These values represent typical characteristics of PVC-U for pipes and fittings.

Characteristic	Unit of measurement	Value
Density	g/cm^3	1,38-1,40
The Charpy impact test	KJ/m^2	4,0
Flexural strength	N/mm^2	95
Yield strength	N/mm^2	50-60
Modulus of elasticity	N/mm^2	≥3000
Vicat sotening point	°C	≥79
Thermal conductivity	W/(m·°K)	0,16
Coefficient of linear thermal expansion:	mm/(m·°C)	0,08
Water absorption at 23°C	%	0,1

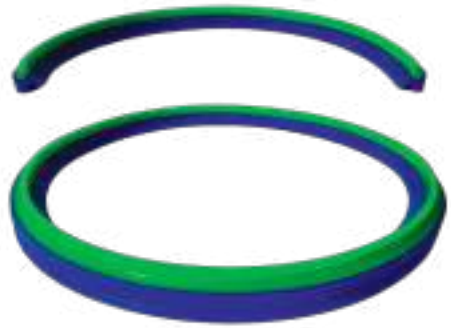
Polyvinyl chloride of the PVC-U brand is resistant to the action of many acids, alkalis, salt solutions, fats, and alcohols. It dissolvesin cyclohexanone, tetrahydrofuran (THF), dimethylformamide (DMF), dichloroethane, limited – in benzene, acetone (swells).

FEATURES OF THE DESIGN OF SEALS

Two-component sealing rings allow use pipes and fittings both in pressure and pressureless external sewage systems.

The composition of the rings consists of 2 materials:
- TPE thermoplastic elastomer;
- polypropylene.

Advantages of this design:
- Maximum sliding during installation;
- The lubrication properties of the rings are maintainned at temperatures from -40°C up to +95°C;
- TPE material keeps as long as possible elasticity, providing one hundred percent tightness.
- Polypropylene adds rigidity to the sealing ring and
- prevents wrinkling during installation



Two-component sealing rings are pre-assembled are installed and lubricated on robotic lines at production of ASG Esterno sewer pipes and fittings.

Pipe marking:

1	2	3	4	5	6	7	8	9
ASG ESTERNO	PVC-U	DN/OD … mm	L … mm	SN8	EN 13476-2,	EN 1401-1,	ДСТУ Б В.2.5-32	Made in Ukraine

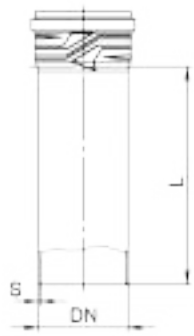
"SAN TEH RAI" Ltd. 462km+100m road Kyiv-Odesa, Usatovo, Biliaivka area, Odesa, region 67663. 21/12/21 21:21

10	11	12

Marking:

1 – trademark;
2 – type of material;
3 – tube outer diameter and wall thickness, mm;
4 – pipe length, mm;
5 – ring stiffness;
6 – EN number that regulates the requirements for technical characteristics of pipes, fittings and plastic piping systems for non-pressure underground sewerage;
7 – EN number regulating the requirements for the main parameters, dimensions, technical characteristics and inspection methods of PVC-U pipelines;
8 – State standard that regulates technical requirements for plastic pipes and fittings intended for outdoor sewerag;
10 – the name of the manufacturer's enterprise;
11 – address of production facilities, index;
12 - date and time of manufacture.

Pipe ASG Esterno



It is used in the arrangement of engineering systems for the removal of all types of waste water
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U

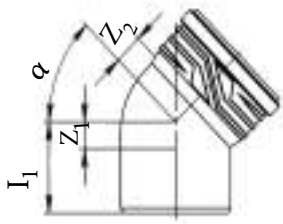
Article	Nominal circular rigidity	DN	S, mm	L, mm	Quantity in packaging, pcs
6553709	SN 4	110	3,2	500	9
6553710	SN 4	110	3,2	1000	60
6553711	SN 4	110	3,2	2000	60
6553712	SN 4	110	3,2	3000	60
6553713	SN 4	110	3,2	5000	60
6553714	SN 4	110	3,2	6000	60
6549622	SN 8	110	3,2	500	9
6549623	SN 8	110	3,2	1000	60
6549624	SN 8	110	3,2	2000	60
6549625	SN 8	110	3,2	3000	60
6549627	SN 8	110	3,2	5000	60
6549628	SN 8	110	3,2	6000	60

ASG Esterno pipe

Article	Nominal circular rigidity	DN	S, мм	L, мм	Quantity in packaging, pcs
6549630	SN 4	160	4,0	500	4
6549631	SN 4	160	4,0	1000	35
6549632	SN 4	160	4,0	2000	35
6549643	SN 4	160	4,0	3000	35
6549644	SN 4	160	4,0	5000	35
6549646	SN 4	160	4,0	6000	35
6549654	SN 4	200	4,9	500	15
6549655	SN 4	200	4,9	1000	15
6549656	SN 4	200	4,9	2000	15
6549657	SN 4	200	4,9	3000	15
6549658	SN 4	200	4,9	5000	15
6549659	SN 4	200	4,9	6000	15
6549660	SN 4	250	6,2	500	12
6549661	SN 4	250	6,2	1000	12
6549662	SN 4	250	6,2	2000	12
6549663	SN 4	250	6,2	3000	12
6549664	SN 4	250	6,2	5000	12

Bend ASG ESTERNO

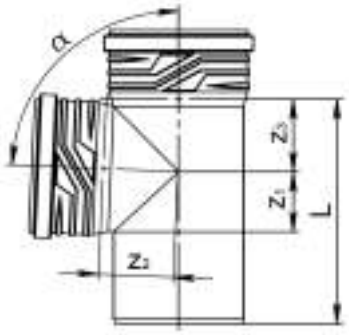
Intended for changing the direction of the pipeline at 15°, 30°, 45°, 67.5°, 87.5°.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	α	Z_1, мм	Z_2, мм	l_1, мм	Number of packaging, pcs
6547876	110	15°	9	15	71	30
6548727	160	15°	13	19	94	10
6548728	200	15°	15	23	114	1
6548729	250	15°	19	30	153	1
6547877	110	30°	17	22	79	30
6548730	160	30°	24	30	105	8
6548731	200	30°	30	38	129	4
6548732	250	30°	37	49	171	1
6547878	110	45°	25	31	87	25
6547881	160	45°	36	42	119	8
6548734	200	45°	46	54	145	4
6548735	250	45°	57	69	191	1
6547879	110	67,5°	40	44	102	20
6547880	110	87,5°	58	63	120	20
6547882	160	87,5°	84	90	167	8

Branch ASG ESTERNO

Used for branching
pipeline at an angle of 45°, 67.5°, 87.5°
with the possibility of changing the diameter.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



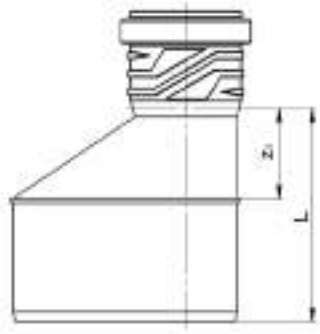
Article	DN	α	Z_1, мм	Z_2, мм	Z_3, мм	L, мм	Number of packaging, pcs
6547885	110x110	45°	25,5	134	134	221,5	12
6547887	160x110	45°	1	168	158	242,0	5
6547889	160x160	45°	36	193	193	312,0	3
6548750	200x110	45°	14	197	182	261,0	2
6548751	200x160	45°	21	223	216	332,0	2
6548752	200x200	45°	48	243	243	386,0	1
6548753	250x110	45°	37	288	206	303,0	1
6548754	250x160	45°	3	254	241	372,0	1
6548755	250x200	45°	24	274	268	426,0	1
6548756	250x250	45°	20	265	292	485,0	1

Branch ASG ESTERNO

Article	DN	α	Z_1, мм	Z_2, мм	Z_3, мм	L, мм	Quantity of packaging, pcs
6547886	110x110	87,5°	64	61	61	187	12
6547888	160x110	87,5°	59	86	64	206	6
6547890	160x160	87,5°	84	89	89	257	4
6548757	200x110	87,5°	61	106	67	248	1
6548758	200x160	87,5°	86	108	91	297	1
6548759	200x200	87,5°	107	113	113	336	1
6548760	250x110	87,5°	64	160	130	330	1
6548761	250x160	87,5°	88	165	135	390	1
6548762	250x200	87,5°	107	160	160	420	1
6548763	250x250	87,5°	131	160	180	460	1

Reducer ASG ESTERNO

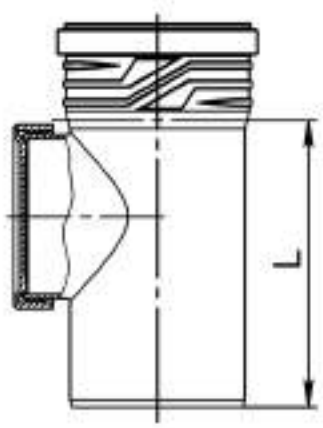
It is used to change from one pipe diameter to another on straight sections of the pipeline.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	Z_1, мм	L, мм	Quantity in package, pcs
6547884	160x110	38	121	20
6548748	200x160	31	130	8
6548749	250x200	38	172	2

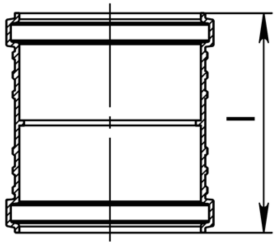
Inspection pipe ASG ESTERNO

Installed for ease of inspection and cleaning the system, without dismantling the nodes and individual pipes.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	L, мм	Quantity in package, pcs
6547883	110	185,5	20
6548745	250	615,0	1

Coupler ASG ESTERNO

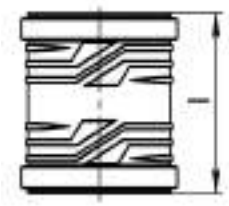


It is used for ease of installation
non-pressure external sewage system.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U

Article	DN	l, мм	Quantity in package, pcs
6547874	110	129,3	36
6547875	160	177,5	12
6548741	200	212,0	4
6548742	250	250,0	1

Coupler mobile ASG ESTERNO

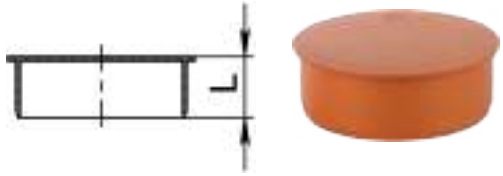
It is used to repair damaged sections of the pipeline.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	l, мм	Quantity in package, pcs
6547872	110	129,3	36
6547873	160	177,5	12
6548743	200	212,0	4
6548744	250	250,0	1

Cap ASG ESTERNO

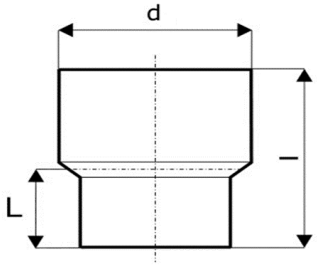
Used for blocking of the system.
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	L, мм	Quantity in package, pcs
6548724	110	39,3	20
6547871	160	60,3	36
6548725	200	65,0	20
6548726	250	89,0	1

Transition to a cast iron pipe ASG ESTERNO

It is used in pressure less systems,for connecting cast iron and plastic pipelines
Service life: 50 years
Maximum working temperature: +60°C
Material: PVC-U



Article	DN	d, мм	l, мм	L, мм	Quantity in packaging, pcs
6548764	160	185	165	98	18
6548765	200	236	220	130	4
6548766	250	-	-	-	1

General conditions

When performing installation work, it is necessary to observe the current rules of safety technology, traffic rules and safety rules of workplaces on the roads.

Project requirements for the laying of external sewage pipelines.
Selection of the ring stiffness class of pipes.

PVC-U ASG Esterno pipes are presented in two classes:
- middle class, this is SN-4 – pipes that can withstand a load of up to 4 kN/m²;
- heavy class, this is SN-8 - pipes that can withstand a load of up to 8 kN/m².

The ring stiffness class is important for the initial deformation when laying in conditions where it is not possible provide support from the sides.

Medium grade SN4 pipes are used for laying at a depth of 0.8 to 6 m with no dynamic loads and where there is little traffic.

Heavy class SN8 pipes are used for laying at a depth of up to 0.8 at a constant high load (for example, a highway), or at a depth of more than 6 m, and are intended for areas with heavy traffic and for industrial areas. When choosing the ring stiffness class of the pipe (which should be done by the designer), the following values are important circumstances: operational purpose, place of laying, depth of laying, quality of initial filling, difficulties in soil compaction, load from transport, as well as soil parameters. The selected ring stiffness class is checked and confirmed by strength calculations.

2. Project Requirements for External Sewage Pipeline Installation.

Pipe laying depth.

There is no limit to the depth of laying PVC-U pipelines. Gravity pipes laid in land, should be calculated on the corresponding loads from the soil and ground transport, so that no the permissible ovality was exceeded, and that the resistance of the pipe section against protrusion was ensured.
The stiffness class of the pipes is selected according to the instructions in Table 1

Table 1. Selection of Pipe Stiffness Class

Installation Conditions	Backfill Material of Pipe	Minimum seal category	Recommended minimum pipe stiffness, kN/m²					
			Pipe laying depth[1]) < 3m			Pipe laying depth[1]) 3-6m		
			Dense soil with good grip	Dense clay	Loose clay	Dense soil with good grip	Sediment and dense clay	Loose clay
Natural soil (no load from ground transport)	Local soil	Without seal	4	-	-	4[2])	-	-
		Lung	4	4	8	4[2])	8[2])	8[3])
	Sand, gravel <22 mm	Lung	4	4	8	4[2])	8[2])	8[3])
	Pebbles, crushed stone 4-22 mm	Lung	4	-	-	4[2])	-	-
Secondary streets with low traffic volume	Local soil	Heavy	4	4	8	4	8	8[3])
	Sand, gravel <22 mm	Heavy	4	4	4	4	4	8[3])
	Pebbles, crushed stone 4-22 mm	Heavy	4	-	-	4	-	-
Main streets with heavy traffic	Local soil	Heavy	8	-	-	8	-	-
	Sand, gravel <22 mm	Heavy	8	8	8	8	8	8[3])
	Pebbles, crushed stone 4-22 mm	Heavy	8	-	-	8	-	-

1. The depth of laying the pipeline in areas with heavy traffic should be more than 1 meter.

2. For depths exceeding 4 meters, heavy tamping is required.
3. For depths of up to 4 meters inclusive.

2.3 Pipe laying depth

A small laying depth is usually considered to be 0.8-1 m, depending on the traffic load.

If the loads acting on the soil are distributed over a rigid plate located on top of the pipe, then the coverage depth should be at least 0.4 m. In some areas, the coverage depth is sufficient half of the outer diameter of the pipe (however, not less than 0.2 m), which is counted from the lower surface behind the slab.

The location of pipelines should be designed in such a way as not to cause disruptions in the functioning of existing communications (table 2).

Table 2.
The distance between sewage pipelines, water pipes and heat pipes

Type of Pipeline	Minimum Permissible Distance, m
Power	0,8
Telephone	2,0
Low-pressure Gas	2,0
Medium-pressure Gas	2,0
Heat Main	1,5
Water Supply	1,5

Particular attention should be paid to the location of sewage networks, if they are located near by pipelines with a temperature higher than the temperature of the soil (heat lines, power cables).

The location of pipelines in relation to other underground facilities must be designed in accordance with industry norms (standards). Also, their location must be coordinated with the owners of these underground networks and objects.

2.4 Strength calculations. Statistical calculations

The use of pipes and fittings made of solid **PVC U** without special calculations is possible, subject to compliance following conditions:

- Load from transport: at full load does not exceed **300 kN**; with wheel loading – no more than **50 kN**;
- The minimum depth of laying the pipeline to the top of the pipe under transport routes is **1.0 m** and below surfaces without transport routes **0.8 m**;
- The maximum depth of laying the pipeline is **6.0 m** when laying in trenches with a minimum width without load from transport;
- The maximum laying depth is **4.0 m** in much wider trenches and when erecting an embankment, without loading from transport;
- The maximum laying depth is **3.5 m** in much wider trenches and when erecting an embankment, with loading from transport;
- The backfill material has the following characteristics: specific gravity (density) cal γ less than **20.5 H/m³**, the friction angle cal φ is greater than 22.5°. Types of soils that meet these requirements are indicated in **DIN 1055-2** (**table1 and 2**, taking into account cohesive mixed soils according to sections **5** and **6**). For cohesive mixed soils,according to DIN 18196, the following soils can be classified: gravel-loam mixture, gravel-clay mixture, sand-loam mixture, sand-clay mixture;
- **DIN EN 1610** storage conditions.

If measures are provided to ensure that bulk material is not eroded (for example, laying in a **gravel filter** layer), then in this case, laying in the groundwater zone is allowed.

2.4 Strength calculations. Statistical calculations

In case of deviations from the above conditions, a calculation is required according to **ATV-DVWK-A 127**.

To perform the calculation, it is recommended to draw up a questionnaire filled out by the customer of the facility with initial data on the facility and hand it over to the installation organization and the pipe manufacturer. In it all important parameters of the object are indicated.

The application letter can be a placement document at the same time in a row Soil compaction and its dense distribution in the pipeline area determine the amount of pipe deformation. If the degree of compaction is reached, load perception is necessary, then further deformations of the pipes there is no

Visual assessment and deformation measurements provide information on soil compaction in the pipeline area and therefore the quality of the gasket. Such control can be carried out immediately after laying the pipes or at any time other time.

According to **ATV-DVWK-A 127**, the long-term vertical deformation of pipes in the assembled state under load should not exceed **6%**. Such a value of the limit deformation will be obtained if immediately after laying it will be **4%**. In the case of non-linear laying, it lasted deformation can be **9%**. This value of ultimate strain will be obtained if immediately after laying it will be **7%**.

The deformation values specified here are not limiting values, but represent a statistically obtained value from measurement, which occurs in **90%** of measurements on the pipeline section.

In some points, higher deformation values are permissible, which are not specified in **ATV.**

2.5 Hydraulic calculations

When designing pipeline slopes, it is necessary to take into account the conditions for obtaining optimal flow velocities,which provide the so-called self-cleaning of pipelines. It is desirable that the speed of self-cleaning channels went even with minimal flows and fillings.

Hydraulic calculations of cross-sections include determination of the dimensions of non-pressure sewer pipelines, the degree of filling with drains, as well as the rate of flow .

Calculations are performed based on the calculation the amount of flow and the accepted slope of the bottom of the channel, as well as the absolute roughness of the wallspipe line and the following accepted conditions:

– The size, shape of the pipeline, its slope, roughness,as well as accepted estimated cost through out pipeline lengths remain unchanged;

– the flow has the same speed at all cross-section points.

For carrying out hydraulic calculations can hydraulic formulas, nomograms should be used and tables in accordance with the requirements of **DBN V.2.5-75:2013 Canalization. External networks and structures.**

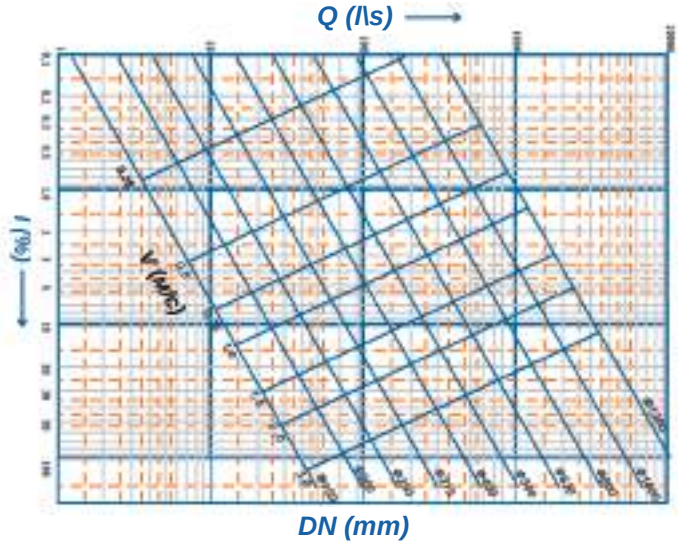


Figure 1.
Nomogram for determining pipeline flow.
Q – flow rate, I – slope, DN – pipe diameter,
V – flow velocity.
The consumption is determined according to the nomogram, taking the roughness value k = 0.25 mm.

The main ones design provisions. Change #1. Amendment #2. General requirements

The calculation of gravity pipelines consists in determining their diameter, slope and operating parameters – filling and speed. Usually, the starting point for the calculation is the cost, which is determined first.To determine the hydraulic parameters of polymer pipelines for smooth walls was developed nomogram **(Figure 1)**.

2.5 Hydraulic calculations

The main parameter when selecting the slope of the pipeline is the need to ensure the self-cleaning process, i.e. to obtain a minimum velocity in the pipeline at which formation on the bottom is not allowed precipitation pipes (table 3, table 4, table 5).

Slope % is defined as: H/L*100%, where H is the height raised by the end of the pipe, L is the length of the raised section.

The speeds corresponding to the conditions of self-cleaning when the channel is completely filled should not be less than:

0,8 m/s – for sanitary sewage;
0,6 6 m/s – for storm sewers;
1,0 m/s – for all-alloy sewage.

The velocities should not be taken as constant, they depend on the diameter of the channel and increase with it increase.

Table 3.

Diameter DN pipes, mm	Sanitary sewerage Vmin = 0.8, m/s		Rainy sewerage Vmin = 0.6, m/s		All-alloy sewerage V = 1.0, m/s	
	уклон I, %					
	к = 0,4	к = 0,25	k = 0,4	к = 0,25	k = 0,4	к = 0,25
160	6,0	4,5	3,4	2,7	9,5	6,5
200	3,4	3,5	2,5	2,0	7,0	5,2
250	3,4	2,6	1,8	1,5	5,2	4,0

Table 4. Approximate values of maximum slopes of sewer pipelines, subject to the adoption of maximum speeds

Diameter DN, mm	Maximum slope I, %, at maximum speed	
	sanitary sewerage Vmax = 5.0 m/s	rain and alloy sewerage Vmax = 7.0 m/s
200	23,0	45,1
250	16,8	32,9

Diameter, DN, mm	Inner diameter, d*, mm	ho/d	Heightpartial filling, ho, sm
110	104,6	0,6	6,0
160	152,0	0,6	9,0
200	190,2	0,6	11,0
250	237,6	0,6	14,0

*Internal diameter is given for pipes of class SN4.

Table 5.

Recommended filling level **ho** for round waste channels with internal diameter d at **Qmax**

2.5 Hydraulic calculations

Figure 2 shows the curves of changes in velocities **V** and flows **Q** in pipes of round cross-section depending on degree of their filling. The degree of filling **hо/d** (ratio of the water level ho to the inner diameter of the pipe **d**), and along the abscissa axis – the velocity **V** and flow rate **Q** corresponding to this filling, expressed in fractions of speed and flow at full filling.

The diameter of the gravity pipeline can be determined by the nomogram depending on the flow rate liquid, the slope of the pipeline and the value of the estimated flow rate. The nomograms are a graphical representation of the Colebrook-White formula under the condition that the water temperature is **10°C** and the pipe roughness is **0.25 mm**.

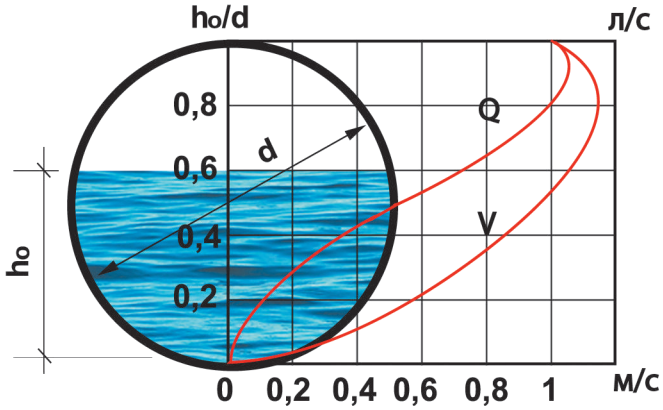


Figure 2.
Nomogram for determining speeds **V** and flow rates **Q** depending on their filling.

3.Transportation, receiving and storage of PVC U pipes

Pipes may be transported by any type of transport in accordance with the rules of transportation and requirements for loading and securing loads that apply to this type of transport. Pipes are transported on cars of the appropriate length with a flat floor, without sharp edges. When transporting by motor vehicle the length of hanging pipes should not exceed 1 m.

When handling the pipes, shocks and mechanical loads should be avoided, and their surface should not be scratched with a depth of more than 0.1-0.2 mm. Pipes must be placed on a flat surface during transportation of the vehicle, using special profile spacers to secure them, and protect against contact with sharp metal corners and edges of the platform.

Transportation and loading and unloading operations must be carried out at a temperature no lower -20°C. Transportation of pipes at temperatures lower than -20°C is allowed only with the use of special means that ensure their fixation and observance of special precautions.

When receiving pipes, fittings and components, it is necessary to carry out an incoming inspection.

During transportation and loading and unloading operations, it is forbidden to subject the pipes to impact load

3.Transportation, receiving and storage of PVC U pipes

It is necessary to store pipes on level areas in stacks. The height of the pipes in the frames should not exceed 3 m. If possible, it is advisable to store them in the factory packaging. Pipes that are laid freely stacked on substrates laid on a flat surface without stones, with an interval of no more than 2 m, and the ends of the pipes do not protrude beyond the supports by more than 1 m. On the sides, there should be high side stops, exposed with such at the same interval as the pads. The pipes must be laid one on top of the other, extending the sockets or applying gaskets. The height of the stack should be chosen taking into account the weight of the pipes and should not exceed 2 m. To prevent involuntary rolling, side supports should be installed near the pipes.

Pipes should be unloaded manually if DN≤160 mm or with a truck loader (truck crane) if DN>160 using standard textile slings. When carrying out loading and unloading works, it is forbidden to drop pipes from vehicles and drag them along the ground.

Pipes of different diameters and stiffness classes should be stored separately from each other. In the case of, if lifting mechanisms are used to lift the pipes, it is necessary to center them and lift them with grips with soft edges.

Using the telescopic method during loading allows you to load a large number of nested pipes. This method of stacking pipes or packages on top of each other saves space warehouse. When moving, it is recommended to protect them from friction and impacts.

Long-term storage of pipes in warehouses with high air temperature is not recommended.
The period of storage in the open area, from the date of production to the start of installation for pipes is no more than 12 months, and for elastomer sealing materials - no more than 24 months."
Avoid contact with substances that can damage the pipes.

4. Technical instructions for installation PVC U pipelines

4.1 Preparation for work

Installation workers familiar with the peculiarities of laying polymer pipelines are needed for the laying of sewers.

The set of tools for cutting and preparing a chamfer on one end of the pipe includes:

– roller cutting devices for **PVC** pipes.

Mechanical tools can be used to prepare pipe chamfers **(Figure 3)**;

– a plastic or hard wood trough (trough) with a cut slots in a plane perpendicular to the axis of the pipe, separately for each pipe diameter **(Figure 4)**

– hand saw-saw for wood with teeth of **2-3 mm**.

The length of the saw should be equal to three diameters of the pipe;

– flat files about **0.3 m** long.

Includes devices and tools for laying and installation sewage pipelines made of polymer pipes include:

– level and theodolite with auxiliary devices;
– laser level;
– measuring tape;
– a device for connecting pipes with tension **(Figure 5)**;
– drilling equipment for drilling holes in pipes for saddle-shaped connections;
– manual wooden and mechanical rammer;
– tripod made of steel pipes, manual winch;
– manual tools for performing manual earthworks;
– mechanical or pneumatic plugs for each pipe diameter, used when covering pipes during repairs works, verification tests for tightness and during washing;
– soft pencil or marker;
– means that increase sliding (silicone grease, liquid soap);
– rags.

Figure 3.
Chamfer remover plastic pipes.

Figure 4.
Wooden step: slot width = DN, height = DN+50mm.

Figure 5.
Execution device socket connections with tension.

4.2 Geodetic measurements and primary earthworks

Geodesic measurements, especially in height, are the most important works during the construction of sewers. To maintain the required slopes of the pipelines, which are determined by %, requires careful measurements onto each section of the sewage route, determined by the location of the sewage wells.

Conditions must be created to protect **PVC U** pipes from excessive cross-sectional deformations interactions of soil stability in the area where the pipeline is located.

Two factors affect soil stability:
1) stability of the protective coating of the pipeline pipe;
2) stability of native soil.

Ensuring the stability of the protective coating of the pipe is achieved thanks to direct coating of the pipeline with loose fine-, medium- or coarse-grained sand with appropriate tamping – sealing. Ensuring the stability of the native soil in the zone of protective filling is achieved due to the absence disturbance of the native soil in the process of digging a trench, regardless of the type of soil. Both types of resistance are interdependent, and therefore it is necessary to observe the conditions both in the methods of digging the trench and in the methods execution of protective dusting.

In case of poor soil characteristics, it is necessary to draw up projects for strengthening the trench and laying the foundation for pipes or, for example, drainage of groundwater.

The design shall show a typical trench cross-section or trench cross-sections at designated locations that adequately characterize the laying requirements.

Elements of the trench design are shown in **Figure 6**.

4.2 Geodetic measurements and primary earthworks

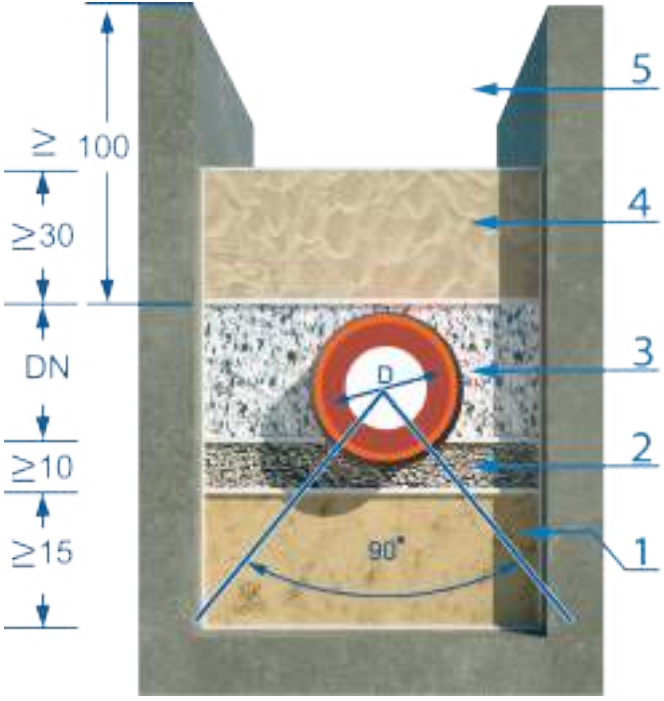


Figure 6. The main elements of the trench design:

1. The base is natural or compacted;
2. The leveling layer is not compacted;
3. Backfill – protective zone, that is manually compacted in layers;
4. Backfill – the area above the pipe, compacted by hand in layers 15-30 cm thick;
5. Backfill – native soil or special, which is manually or mechanically compacted.

Backfill – the protective zone and the zone above the pipe (compacted initial filling) together with the pipe forms an arch structure in which the elastic pipe transfers vertical loads to the lateral filling.

As the loads increase, the resistance increases, and the change in the shape of the pipe remains at the same level for two years.

4.3 Making a trench

Continuous trenches can be used for the construction of sewage pipelines narrow spaces with vertical walls, plank fastening with spacers, as well as trenches with slopes without fastening, for a certain level (depth). The choice of the type of trench, the method of preventing its walls depends on local conditions, trench depth and hydrogeological conditions. Passing under obstacles can be carried out by pushing through protective pipes or tunneling with fastening.

Narrow-space trenches with vertical walls with plank fastening with spacers provide the condition of inviolability of the structure of the native soil, i.e. stability in the zone of protective backfilling of the canal pipe, according to under the condition that above the upper level of this backfilling, solid board fastening must be made.

Wide-span trenches with walls with slopes, which are performed by mechanisms up to the level (marking) of pipeline laying, cannot be used due to the impossibility of ensuring the preservation of the structure of the soil in the zone of protective embankment of the pipeline, especially taking into account atmospheric precipitation and availability groundwater. Wide trenches with walls of with slopes performed by mechanisms, it is necessary to excavate to the level of the pipe backfill. Below this level, it is necessary to use narrow-space trenches with vertical walls, continuous board fastening, as shown in **Figure 7**.

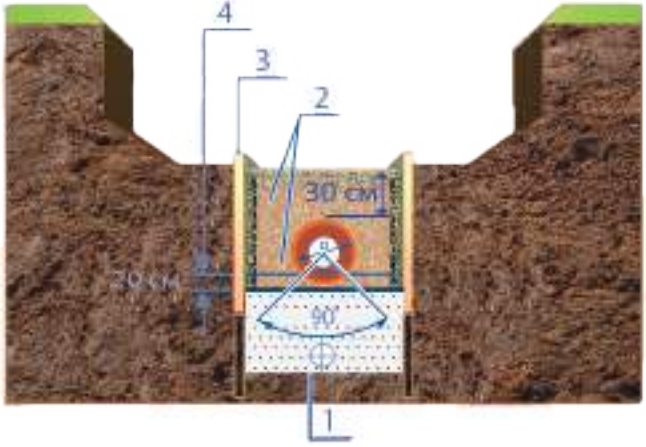


Figure 7.
1 – drainage system;
2 – pipe filling;
3 – continuous independent fastening of the trench;
4 – the design depth of the pipeline.

4.3 Making a trench

The above-mentioned form of the trench ensures the preservation of the structure of the native soil, regardless of its type and possible precipitation. If there is groundwater that can be removed, it is necessary to apply a horizontal drainage system, which must be localized in the channel width zone.

With deep trenches and groundwater levels, it may be necessary to abandon wide trenches due to erosion of the slopes in the lower parts of the trench. In this case, apply trenches with vertical walls with board fastening or a combination of both types of trenches.

Narrow-space trenches are used in built-up areas in limited spatial conditions – for example, on the streets of cities or towns. When digging trenches using mechanical excavators cannot exceed the depths established for mechanized work.

When making trenches in sandy soils that meet the conditions of protective backfilling of canal pipes, it is not necessary to leave a layer of soil **5-10 cm** higher than the design mark at the bottom of the trench for placing the pipes trenches Profiling the bottom of this trench according to the form for **PVC U** pipes, as well as the design slope is performed immediately before laying the channel pipes.

When making trenches in hard soils, the trench must be made 0.2 m lower than the design one marking the bottom of the channel with subsequent sprinkling of sand without lumps and stones. Laying of excavated land, should be performed only on one side of the trench at a distance of at least 0.6 m from its edge. In case of contact with a layer of peat, it must be completely removed before entering the permanent soil, and the freed space fill with sand to the level of the design mark of the trench.

The trench should be dug as narrow as possible, but not narrower than **DN+ 0.4 m**. The bottom of the trench should be flat without stones and blocks. The minimum width of a trench that is secured or unsecured (**with inclined walls**) is indicated in **table 6. Table 7** presents the minimum width trench depending on its depth.

4.3 Making a trench

Table 6.
The minimum width of the trench depending from the diameter **DN**

Nominal diameter DN	Minimum width, m		
	Fixed trenches	Loose trenches	
		Angle of repose > 60°	Angle of repose ≤ 60°
≥ 225	DN + 0,4	DN + 0,40	
> 225 до ≤ 250	DN + 0,5	DN + 0,5	DN + 0,4

Table 7.
The minimum width of the trench depends from its depth

Trench depth, m	Minimum width, m
< 1	is not regulated
≥ 1 ≤ 1,75	0,8
> 1,75 ≤ 4	0,9
> 4	1

The fastening of the trench walls should be

- continuation of deepening of the fastening of the upper part of the narrow trench;
- independent.

It is recommended to continue the deepening of the horizontal fastening of a narrow trench, based on the conditions of further backfilling, from narrow boards with a width of **10-15 cm**, taking into account the spacers. The density (**tightness**) of the board fastening (**openwork – dense**) depends on the soil and water conditions of the zone channel.

Independent fastening can be in the form of horizontally located boards with spacers, densea (**vertical**) wall, or a trench in the channel area does not require fastening.

The type of fastening used or its necessity depends on the soil and water conditions of the area channel (**type of soil, pressure of groundwater or its absence**).

Installation work is carried out in trenches with a drained base.

4.3 Making a trench

The dried base allows you to form a recess under the pipe, mount the connection, and also withstand it given design slope of the channel. During the construction of sewers, depending on the depth of the trench, the type of soil and degree of lowering of the water table, 3 ways of drying can take place:

1) surface method of drainage – consists in draining water as the trench deepens. He does not demand installation of complex devices and often enough to install on the surface of a manual or motorized internal combustion of the membrane pump;

2) the method of horizontal drainage – includes the installation of a horizontal drainage channel under the area sprinkled with gravel and drainage of water to storage wells located along the route of the canal, from where water is diverted to receiving tanks with the help of pumps. After laying the channel and after after the tightness tests, the drainage is shut down, and the storage wells are dismantled;

3) the method of static horizontal lowering of the soil mirror – is used in the case of high soil hydration and requires the presence of depression wells or the use of needle filters.

Pipe supports are support structures that are mounted under the leveling layer. The method of laying the foundation must be specified in the project. If the pipeline cannot be laid directly on the bottom of the trench, u the project indicates the construction of the base.

When performing pipe laying work in winter, you should pay attention to the fact that the material under the pipe does not freeze.

If necessary, the bearing capacity of the soil at the base of the trench is strengthened with the help of lime or cement stabilization.

4.3 Making a trench

The support is also the lower part of the protective lining of the pipe. The thickness of the leveling layer, performed on the ground, should be at least **150 mm**. If a specific material is not specified in the project, then it should be choose sand, gravel or crushed material with the required characteristics. When using crushed material, the grain size should not exceed **16 mm**.

The maximum grain size used as a leveling layer material, namely sand or gravel for pipes **DN 110-250** mm should be **10%** of the pipe diameter.

If the base soil meets the requirements for the granulometric composition of the leveling layer material, then there is no need to use it for pipes that are laid outside the traffic are a separate leveling layer.

Depending on the type of soil at the level of channel laying, there are **4** types of foundation (**Figure 8**).

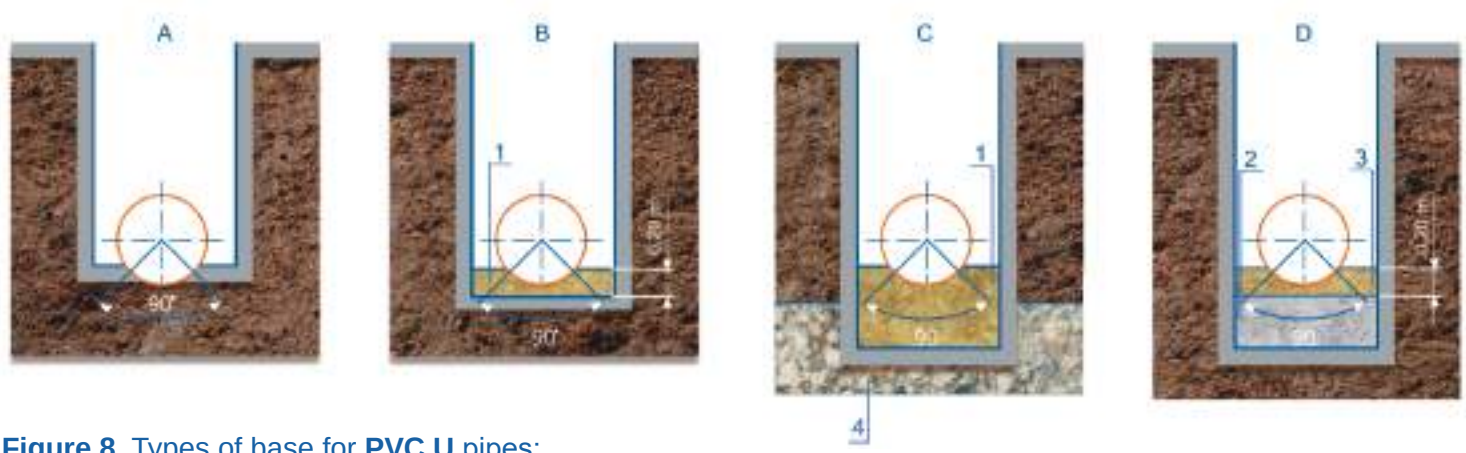


Figure 8. Types of base for **PVC U** pipes:
1 – sand compaction; 2 – reinforced concrete slab; 3 – sand; 4 – soil with low bearing capacity.

- **Type A** is a natural base. The bottom of the trench is dry, sandy, coarse, medium, and fine-grained soils with an average grain diameter of **0.05** to **2.0 mm** and without stones. In these conditions, **PVC U** pipes are laid directly on a leveled base with a profiled bottom, which is the supporting bed of the channel pipe;
- **type B** – bulk foundation. The bottom of the trench – rocky soils: stone rubble, weathering, dusty sands, and viscous soils such as clays or silts. The conditions for pouring **PVC U** pipes require a base made of compacted sand. The thickness of the sand base with diameters of **DN 200-250 mm** and a viscous base is **0.2 m**. For with diameters of **DN 110-160 mm**, the thickness can be reduced to **0.15 m**;
- **type C** – bulk foundation. The bottom of the trench – soils with low bearing capacity, such as silt, peat and others with a relatively shallow deposit. Conditions of stability of protective dusting of **PVC U** pipes require removing these soils and replacing them with compacted sand up to the pipe laying mark;
- **type D** – bulk foundation. The bottom of the trench, as for type **C**, but with a deeper soil layer from low carrying capacity. The conditions for the stability of the protective coating of **PVC U** pipes require the execution of a reinforced base: concrete or reinforced concrete slabs with a compacted base of sand with a thickness of at least **0.2 m**.

The bottom of the trench under the foundation in good soil conditions (dry and friable or moderately compacted soils) must be done with an accuracy of **2** to **5 cm** (in the vertical and horizontal plane) depending on the method deepening – in relation to the given design marks. The so-called "**excavation**" is the excessive excavation of native soil must be filled with rammed sand.

If there is groundwater, the trench must be drained. The surface of the base – both natural and artificial – made of rammed sand, must correspond to the design slope. For all four types of foundation is required longitudinal profiling of the bottom within an angle of **90°** with the design slope, which is the supporting bed of the pipe. Possible losses in the height of the base or leveling layer must be leveled exclusively with sand.

4.4 Quality control during implementation pipeline installation works

The quality of construction work must be documented. At the stage of installation of pipes and fittings, it is necessary constantly carry out current inspection and control by own or engaged specialists. There should be control works confirmed, i.e. have confirmation of the competence of the controllers. This will ensure proper construction work.

During the quality control of works, the main thing is a visual and measuring inspection.

Visual and measurement inspection of pipeline elements and auxiliary devices includes:

- monitoring the operation of mechanisms for installing pipes;
- constant monitoring of the laying direction, laying height, slope of pipes and fittings with application laser level;
- inspection of damage to pipes and fittings;
- control of pipe connections;
- connection control.

Pouring pipes should be carried out only after a thorough check of the correctness of the laying of the pipeline.

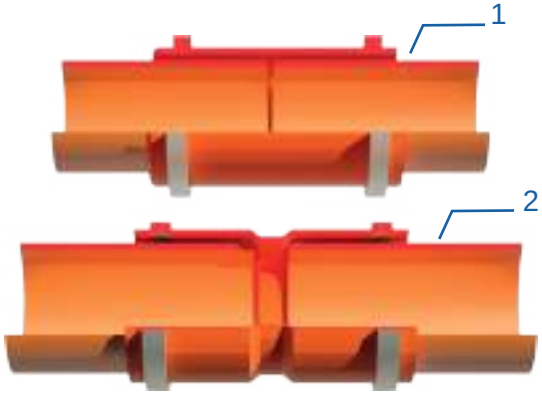
4.5 Connection of pipelines

Before assembling pipes and fittings, it is necessary to check for possible damage. It is also necessary to check the manufacturer's factory mark, the approval number or **DIN** and the designation of the pipe. It is recommended to lay the pipeline at an ambient temperature above **0°C**. At a lower temperature **-5°C**, it is necessary to act carefully and avoid any impacts with the pipe and on the pipe. Below **-20°C** it is forbidden to carry out any work with pipes.

The main type of pipe connection is a socket connection with tension using sealing rings with elastomer The design of the sealing ring with elastomer with polypropylene reinforcement provides reliable fixation and excellent tightness. Pipes and fittings are supplied with the ring installed.

If it is necessary to remove the sealing ring from the socket, it is necessary to carefully remove all dirt, and wipe the surface of the recess with a rag. It is also necessary to carefully wipe the sealing itself ring and rinse in water.

Reductions, double couplings or couplings push-on couplings with sealing (**Figure 9**).



In transitions to cast iron, ceramic, asbestos-cement or concrete pipes, in addition to the above-mentioned connections, transitions to cast iron pipes are used.

Figure 9. Socket connection:
1 – sliding clutch,
2 – double coupling.

4.5 Connection of pipelines

When installing pipes, it is sometimes necessary to shorten the pipe to the required length. Transverse cutting of the pipe must be performed in a plane perpendicular to the pipe axis.

A device that allows you to maintain the accuracy of the cut is a wooden jig with the appropriate size for each pipe diameter (**Figure 10**). Roller pipe cutters can be used to cut pipes, which guarantee cutting the pipe in a plane perpendicular to its axis.

Mechanical processing of fittings is not allowed.

At the end of the pipe after cutting, it is necessary to make chamfer (**Figure 11**). Execution of chamfers after cutting pipes is an operation to give the pipe ends a conical shape in order to ensure the concentricity of the end insertion into the bell and its smooth transition through the sealing ring.

This operation consists of the following stages:

- marking of the amount of processing (**Figure 11, Figure 12, Table 8**);
- forming a chamfer on the end with the help of plastic pipe chamfer or file;
- alignment of the processed surface and faces with a file; removal of chips from the pipe.

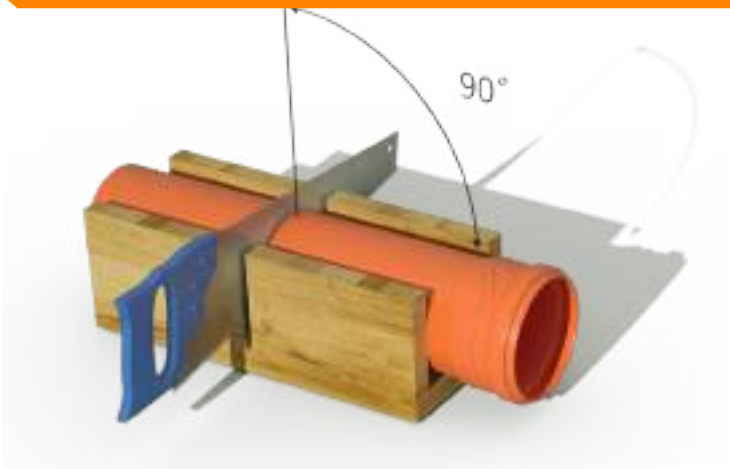


Figure 10. Application of a wooden stick

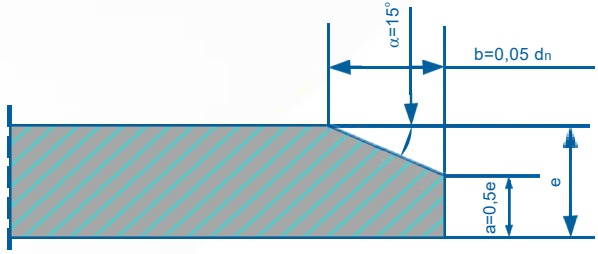


Figure 11.
Dimensions for processing the uncut end pipes

4.5 Connection of pipelines

Each smooth end of the pipe is intended for landing in the socket of the next element (**pipe, fitting**) must have the mark that determines the depth of the installation landing – is measured by lm (**Figure 12**).

The installation depth of the landing must guarantee the possibility of compensation of significant thermal linear elongation of the pipeline, if such may occur. It is not allowed to install pipes with a full fit (**«to stop»**) of the smooth ends of the pipe into the sockets of the following elements (**pipes or fittings**).

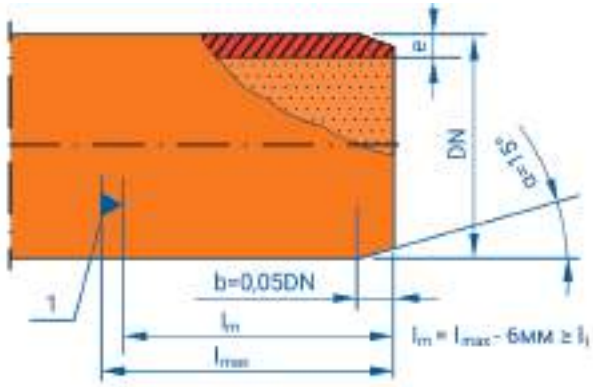


Figure 12.
Designation of planting depth:
1 – planting depth

Table 8. Dimensions* for finishing the face of the bare end of the pipe and the depth of planting

DN, мм	e, mm	a, mm	b, mm	l_{max}, mm	l_m, mm
	deviation ± 0,2 mm			deviation ± 2 mm	
110	3,2	1,6	5,5	76	70
160	4,0	2,0	8,0	110	104
200	4,9	2,5	10,0	120	114
250	6,2	3,1	12,5	140	134

* The dimensions are given for SN8 class pipes with DN 110 mm and for SN4 class pipes with DN 160-250 mm

4.5 Connection of pipelines

Marking the planting depth can be done as follows:

- it is necessary (**for the period of measurements**) to remove the sealing ring from the pipe socket or shaped part;
- insert the bare end of the pipe into the socket up to the stop **(value l_{max});**
- use a marker to mark a thin line on the bare end of the pipe – the maximum planting depth (**Figure 11**);
- mark the mounting depth of planting with a triangle. For effluents with a temperature of up to **20°C** l can be accepted **$l_m = l_{max}$ – 6 мм ≥ l_1**, where **l_1 – – the minimum planting** depth of the bare end of the pipe. The marking of the triangle is done with a quick-drying paint **(marker)**;
- measure the value of **l_m** and using a tape measure or a manufactured template, mark all pipes of the same **DN** in three places along the perimeter of the pipe.

PVC U pipe segments can be connected with adhesive couplings.

It is recommended to carry out gluing in the temperature range of the environment from **+5** to **+40°C**.

4.5 Connection of pipelines

At the same time, you need:

- remove burrs left after sawing;
- remove the chamfer on the outer surface of 2 pipes at an angle of **15°** to ensure the correct insertion of the pipes into clutch;
- clean the ends of the 2 inserted pipes, outside and the coupling inside from dirt;
- mark from the ends of the 2 pipes a distance equal to half the length of the coupling;
- remove all traces of contamination using a tissue or an applicator moistened with a primer-cleaner from the outer surface of the two pipe ends and from the inner surface of the coupling. After applying the primer, leave to sew for a few minutes to dry;
- apply the glue uniformly in the longitudinal direction on the 3 components to be connected using an applicator or a brush of the appropriate size. It is recommended to use a size applicator/brush not less than half the diameter of the pipe. Glue must be applied to the entire length of the connecting surfaces: to the entire length of gluing of 2 pipes on their outer surfaces and to the entire inner surface of the coupling;
- immediately insert one pipe into the coupling to the mark and, holding it in this condition, insert the second pipe. Insert without turning. Scrolling after ¼ turn is allowed. Rotation helps more uniform distribution of glue;
- pipes must be inserted quickly, no more than **25-30 seconds**. The operation must be carried out manually with external diameters of pipes up to **160 mm**. For diameters of **160 mm** and more, use mechanical pushers.
- immediately remove adhesive residues from the surface of pipes and couplings with copy paper or a napkin;
- drying of the glue: it is necessary to withstand the following minimum time intervals depending on the temperature environment: before moving the connection – **5-10 minutes** for an environment temperature of more than **10°C**, **15-20 minutes** for an ambient temperature of up to **10°C**; for connections that cannot be tested under pressure – **1 hour**; for connections up to **PN 16** of any diameter subject to pressure tests – no less than **24 hours**. In some cases, the load on the pipe (for example, when testing for tightness) can be applied after **3-4 hours**.

  The adhesive must comply with **DIN 16970**.

4.6 Installation of PVC U pipeline

When laying pipes, you need to maintain a straight line and the necessary **slope**. Pipes are installed on top of the soil or leveling layer in such a way that there is no bearing load on the socket.

For the bell, it is necessary to make an installation pit of approximately 0.1 m (**Figure 13**).

This is necessary to install the pipe on the base along its entire length. The shape and dimensions of the installation pitmust ensure compliance with cleanliness conditions – prevent sand from entering the socket.

The socket of the pipe being laid, if necessary, must be protected by the appropriate technological plug.

The thickness of the leveling layer for viscous soils for diameters **DN 200 – 250 mm** should be **0,2 m** (**Figure 13**). For diameters **DN 110 – 160 mm**, it can be **0.15 m**.

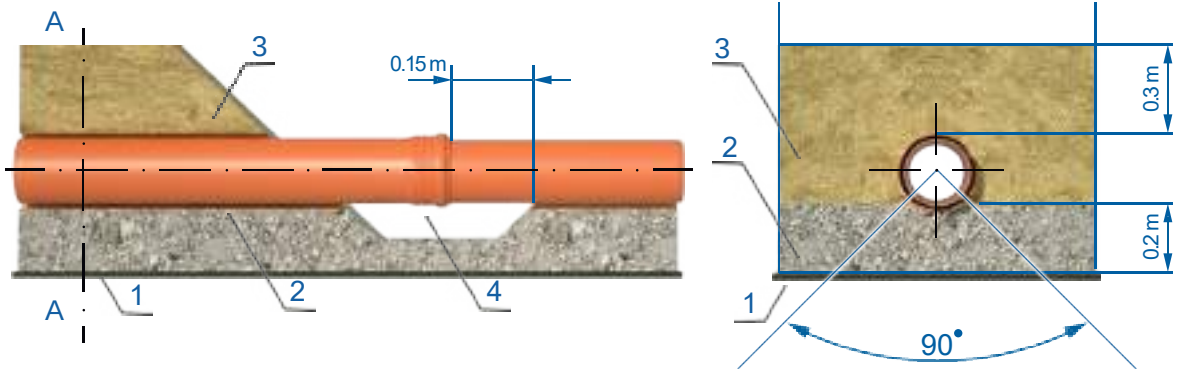


Figure 13.

1 – soil;

2 – leveling layer or basis;

3 – protective layer with sand (dust);

4 – mounting hole.

Installation of a socket joint is an operation to insert the smooth end of one pipe into the socket another pipe or fitting. Before starting planting, the socketless end of the pipe must be lubricated with a means that increases gliding, which makes landing much easier.

The use of lubricants for these purposes is unacceptable. When installing **PVC U** pipes, it is necessary to ensure that so that there is no ice in the bell and on the sealing edge. Silicone-based friction reducer in cold weather, it works better than a similar water-based substance.

4.6 Installation of PVC U pipeline

The fitting of the socket-less end into the socket of the next pipe of the pipeline can be carried out using a special pressing device, or with the help of a ring clamp and a single lever. Protective Plugs from pipes and fittings should only be removed immediately before making connections. Sewerage pipes with diameters up to **160 mm** can be assembled manually. For pipes with larger diameters (**160 mm and more**), appropriate devices are used (**Figure 5**).

If during construction there is no device for indentation, this operation can be performed manually with the help of a lever (**Figure 14**).

Figure 14. 1 – a wide wooden bar

A condition for performing a socket connection is such laying of pipes, in which the axes of the connecting segmentsare on the same line. In the case of using a manual lever driven to a depth of **0.3 m** into the soil, the levermust rest on the end of the pipe through spacers made of solid wooden square blocks. The fitting of the socketless end into the socket of the next pipe must be brought to the depth previously marked on the surface of the pipe.

The pipes must be inserted concentrically, one to the other in the direction of the pipe axis. It is necessary to check the accuracy direction and, if necessary, correct after connection. Laying of **PVC U** pipes at the bottom of the trench is carried out on a base that is completely drained and profiled in accordance with the design slope

4.6 Installation of PVC-U pipeline

Non-pressure sewer pipelines with diameters of **DN 110 – 200** can be laid not only in a straight line, but and as shown in **Figure 15**.

Figure 15. Bending parameters of a **PVC-U** pipe

At the same time, the values of the pipe bending parameters listed in **Table 9** cannot be exceeded.

bend		h, m		
DN, mm		110	160	200
R, m		33	47	61
L, m	8	0,24	0,17	0,13
	12	0,54	0,38	0,30
	16	0,97	0,67	0,53

Table 9.
Maximum size h and bending radius R at length L

4.6 Installation of PVC U pipeline

PVC U pipes with a diameter greater than **DN 200** bend very little due to their high inherent rigidity. But small changes in direction are possible. Due to the large gap in the bell and the large volume of the sealing ring, additional deviation in the bell is possible for all sizes. It is about 0.5° (corresponds to approximately **5 cm** deviation per **5 m** length).

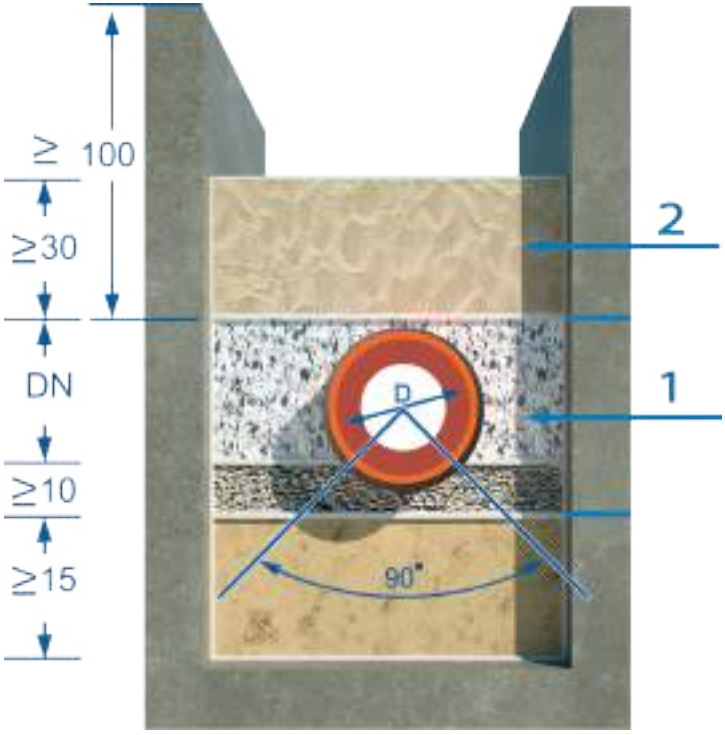
The construction of the sewage network starts from the nodal points – sewage wells, mainly inspection, equipped in accordance with the project markings, hermetic transitions for pipes. Construction of the channel is carried out in accordance with the established projects of the slope between nodal points from the lowest from the marks to the highest sections of **5 m**.

Ensuring the necessary slopes by placing pieces of wood, stones or construction waste under the laid pipes is not acceptable, because the pipe needs reliable support along its entire length.

Butt-socket joints do not accept or accept very little axial loads (for example, when pressing), so loose fittings, for example, taps and tees, shift under the action internal pressure. To avoid this, it is necessary to fix free-lying pipelines with wooden ones or plastic pegs, stops or clamps that provide stability against shifting.

After checking the correctness of the slope, the laid section of the pipeline is covered with a protective layer from sand to a height of **0.1-0.3 m** above the top of the pipe (**Figure 13**). After hydraulic tests are performed complete backfilling of the entire pipeline (including installation pits) to the design height

4.7 Initial Filling trenches with pipes



Filling the trench with pipes is done in three stages:

stage I – implementation of the protective layer (**initial filling**) of the pipeline with the exception of sections inplaces of connections (areas with sockets and adhesive clutches);

stage II – after conducting hydraulic tests joints – implementation of a protective layer in placesconnections;

stage III – filling the trench with native soil or special layers with simultaneous compaction and, if necessary, with the removal of the wooden formwork and disassembly of wall spacers.

Initial filling means material, which is above the leveling layer (filling), which is laid around the pipe and above the top of the pipe.

The height of the backfill above the pipe should be minimum (Figure 16):

- **15 cm** for pipes **DN<160**;
- **30 cm** for pipes **DN>160**

Figure 16. Initial filling of the trench with pipes:
1 – Backfill – a protective zone that is manually compacted in layers;
2 – Backfill – the area above the pipe, manually compacted with layers **15-30 cm** thick.

4.7 Initial Filling trenches with pipes

Taking into account the external texture of the pipe surface, it is necessary, when performing individual layers of the protective zone of the pipe (filling and backfilling layers up to a height of **0.15-0.3 m** from the pipe surface), to use material that does not contain fractions larger than 8 mm.

The material of the initial filling must meet the same requirements as the material of the leveling layer. The material must not freeze.

The initial filling is performed directly during the laying of the pipe. At the same time, the latter will be protected from stones, etc., falling from the edges of the trench.

The filling is compacted in layers, the thickness of which depends on the type of soil and the method of compaction, whichis applied. Sealing of the material is of decisive importance for maintaining the shape and strength of the pipe initial filling and its quality.

The most important problem in soil compaction is compaction of the soil in the so-called pipe sinuses (the lateral sections between the pipe and the trench wall) and filling of the space under the lower part of the pipe.

Properly performed compacted filling ensures uniform fixation of the pipe and prevents its displacement both in the lateral and longitudinal direction. Tamping in the sinuses must be done with wooden sticks from solid wood (**Figure 17**).

Application of both metal and mechanical bumps are allowed at a horizontal distance of about **0.1 m** from the pipe.

Backfill material must not be dumped into the trench, as this may damage or dislodge the pipe.

A trench (pit) with horizontal formwork must be unfastened as follows:

- lay a layer of filling 1/3 DN high and compact;
- remove the board;
- lay and compact the next layers of backfill to a height of about 5-10 cm from the bottom on the foot board, paying special attention to filling and compacting the space previously occupied by the board.

Replacement cycles are repeated up to the upper horizontal mark of the pipeline, i.e. 0.3 m higher for the level of the top of the pipe. Wooden airtight walls, the use of which was necessary due to soil conditions and high groundwater levels, are not removed. Leaving them below level of groundwater allows maintaining the stability of the soil in the area where the pipes are buried.

The initial filling is compacted in layers no more than 1/3 DN thick.

Figure 17. Compaction (tamping) in the sinuses

4.8 Connection of pipelines with wells

Installation of plastic wells, depending on their purpose, is necessary in the entire sewage network. When using sewage wells, the following circumstances must be taken into account:

- the bottoms of the wells, even together with the connecting shaft, have a small mass and during installation for connection for them, pipes with the tension of this mass are not enough, especially if the well has several connections from different ones directions and is one of the main nodes in the sewage system;
- the small mass of the wells makes it difficult to install them in the given coordinates (in height and horizontally);
- during the construction of both the local sewage network and the unifying connecting wells, they are the most frequent nodes of the sewage system.

Node wells should be:

- made with planning and height binding on the appropriate foundation with sand filling;
- be located at a distance of up to **50 m**;
- be the endpoints of this pipeline section.

On the section of the pipeline between the end points, node wells can be:

- passage small-sized wells – control wells;
- connecting small-sized wells;
- closed – saddle-shaped connections; one change of direction using a lead in the range of **15-90°**.

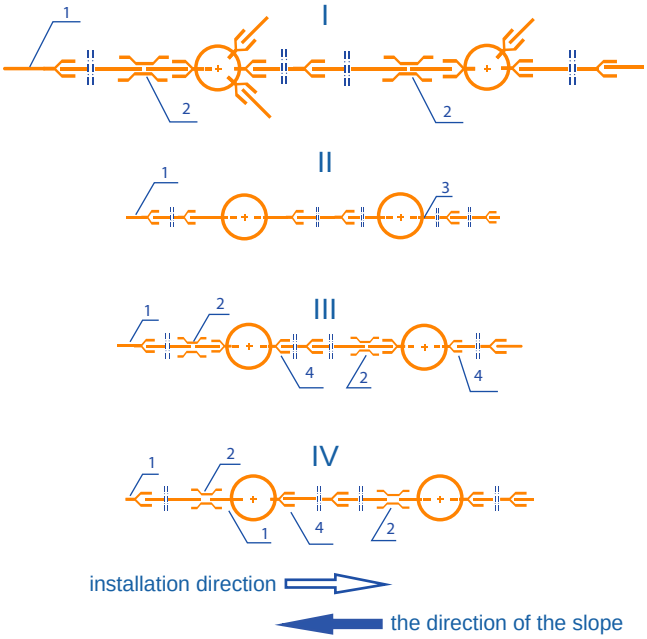
The width of the trench should be sufficient to freely connect the pipes to the well.

This connection is performed similarly to the connection of flared pipes (the bottom of the well is equipped with ringsseals). The thickness of the backfill under the well should be the same as the thickness of the backfill under the pipeline.

The fill on which the well is installed can be formed in two ways:

- the trench must be deepened, and the well must be installed on a bed of material removed from the trench after appropriate selection and compaction;
- the brought loose material must be placed in a trench and compacted.

4.8 Connection of pipelines with wells



Suitable material for backfilling and filling around the shaft of the well can be obtained by selection of soil removed from the trench or brought. The material used for backfilling the well must be the same as that used for backfilling the pipeline.

Filling the space around the plastic well must be made of unfrozen material at least than by **0.3 m**. The requirements for particle size composition are the same, as for pipes of the appropriate size.

The material used to backfill the trench,should not contain sharp stones, earth blocks, lime or frozen ground.

If an additional pipeline is required foundation, such a foundation must also have a well.

Types of wells used and associated with them hermetic connections (wall transitions, sockets or bare ends) require either their direct application, or the use of connectors - sliding couplings.

Sample joints of nodal wells are shown in **Figure 18**.

Figure 18. Connection of PVC U pipes with wells:
I – connection of pipes with plastic wells with factory sockets at the entrance and exit;
II – connection of pipes with inspection wells with a wall transition;
III – connection with inspection wells with a flare transition;
IV – connection with inspection wells with a flare transition and exposed ends.
1 – pipe with bell; 2 – sliding clutch; 3 – wall transition; 4 – transition to the s/b well.

4.8 Connection of pipelines with wells

The construction of wells should be carried out in accordance with the technical documentation, which takes into account the conditions application of pipes. In the pipeline system, the method of pushing the flared end of one pipe into the flare of another is mainly used. Taking into account the mass (weight) of wells and pipes, laying the pipe with tension is not difficult.

An example of the use of wall transitions in a well is shown in **Figure 19**.

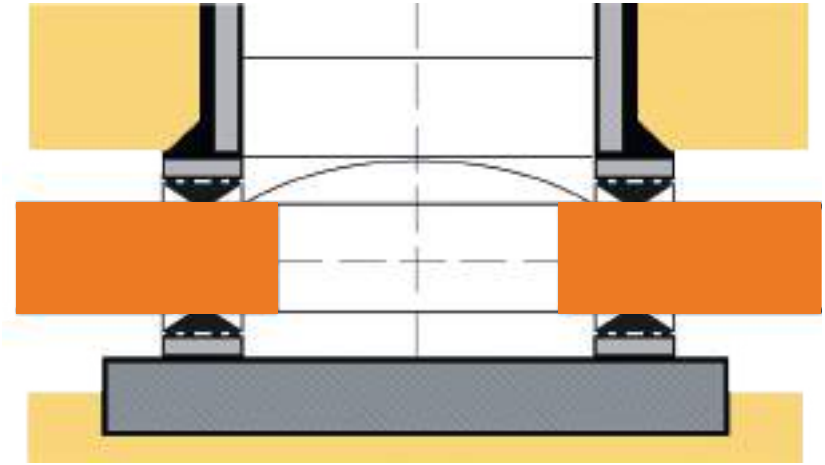


Figure 19. Installation of wall transitions in the well.

4.9 Pipeline connection to the main channel

Connections for future sewage pipelines must be planned and installed at the same time as the street sewer collector. At the same time, branching at an angle of **45°** is better **(Figure 20**).

At the ends of the pipes and branches, install hermetic plugs that match the piping system. By if necessary, they must be secured from being squeezed out by internal pressure.

You should pay attention to the layer that needs to be compacted especially carefully. Facing from concrete to do not recommended.

Connecting pipelines should be assembled and connected in such a way that they can accommodate movement.

The possible subsidence of the soil in the connection area should be especially taken into account.

If, due to local conditions, it is not possible to avoid the vertical arrangement of pipelines, it is recommended to make the connection from the side between the backfill area and the top of the pipe vault, as shown in **Figure 21**. It is recommended to use fittings with an angle of **45°**.

The corresponding vertical channel ends with a tap. The fitting group should be embedded in sand.

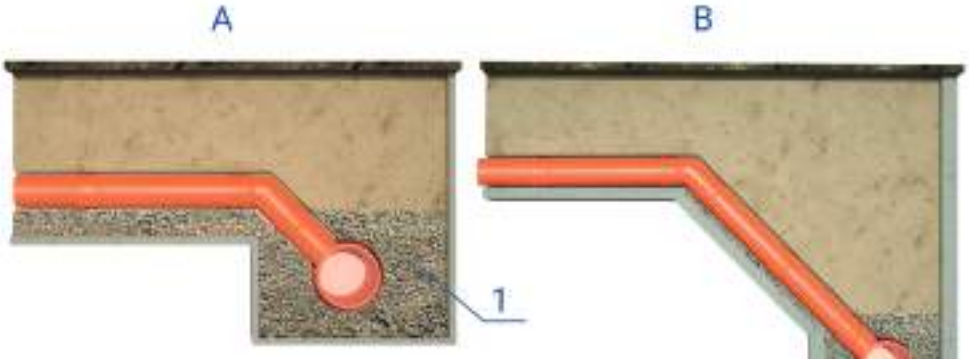


Figure 20. Sewer connection in the backfill layer:
A – with a slight difference in the levels of the laying, the entrance angle is 45°;
B –for any difference in the levels of the gasket, the entrance angle is 45°.
1 – - a layer subject to particularly strong compaction.

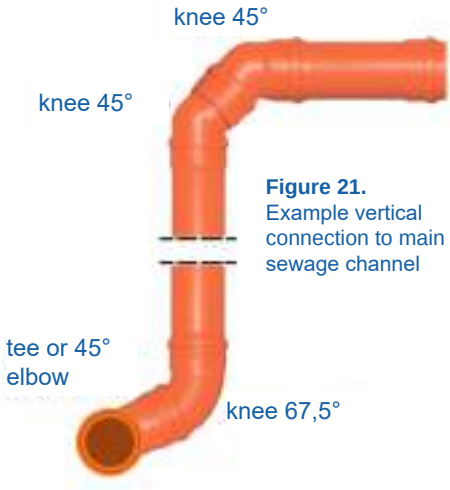


Figure 21.
Example vertical connection to main sewage channel

4.10 Pipeline installation in difficult conditions

During the construction of sewage networks from plastic pipes, some sections of the route may appear conditions that require special methods of laying, which are called transitions under or over obstacles.

Transitions under obstacles may include:

- transitions under building foundations;
- transitions under public highways with difficult traffic conditions;
- crossings under tram tracks;
- crossings under railway tracks.

The design solution of sewer transitions with pipes requires coordination with their users. The prescriptions of some users of these highways - such as railway tracks and public roads - are very clearly defined in terms of materials, laying depth, methods of work and other precautions.

When passing under the foundations of buildings, the following conditions must be observed:

- the design solution of the passage under the foundation must take into account the protection of the foundation in relation to the required width and height of the pipeline laying.
- the laying of the pipe of the pipeline must meet the requirements of its laying in the trench, that is, it must be carried out with the use of protective filling, as well as taking into account the backfilling of the trench;
- the distance between the bell or pipe and the bottom of the foundation should be 0.15 m.

In the construction of sewers under crossings, such as public roads or railway tracks, pipes are laid with vertical wall fastening.

It is necessary to provide unloading structures for rail communications. Laying pipes must comply with all the conditions given in this manual. In special cases, for example, when overcoming railway tracks with a high embankment, a steel protective pipe passed under the embankment can be used by pressing. The inner diameter of the protective pipe must be selected in such a way that the distance between the pipe bell and the inner wall of the protective pipe was 6 to 8 cm.

The introduction of plastic pipes into the protective pipe must be carried out on special plastic centering clamps rigidly fixed on the pipe.

4.10 Pipeline installation in difficult conditions

Basic requirements for the design of centering plastic clamps:

а) pipe sockets must lie and rest on protective pipe,
б) it is not allowed to bend the pipe between the sockets,
в) clamps must be located:
- directly on pipe sockets;
- the distance between the clamps on the pipe should be:

  - **0,5 m** – for pipes **DN 110** and **160** mm;
  - **0,7 m** – for pipes **DN 200** and **250** mm

Pipes should lie on supports with a recess on profiles with **R = DN** and a coverage angle width of **90°** for the given diameter The width of the collar is **6-8 cm**, the lower part the support should have a profile of the inner diameter of the chimney pipe. Pipe section intended for laying in the protective pipe, before entering it, it is necessary to test the tightness of the connections on the adjacent territory.

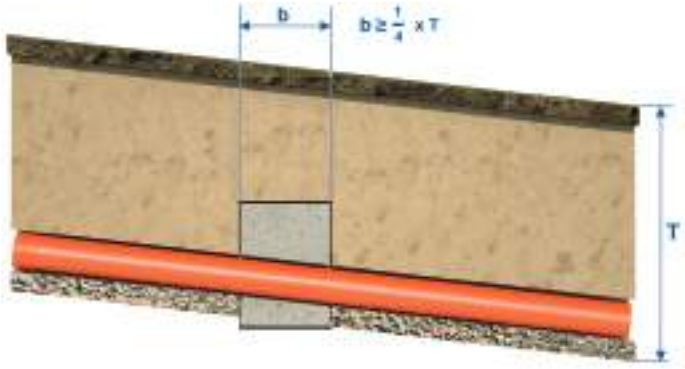


Figure 22.
Pipe laying on steep slopes:
1 – concrete shutter (cladding)

Passages of sewage pipelines over obstacles, for example, a river or a ravine, are found very rare and require individual processing. The application of such a transition of pipes is also possible up to one piece. The construction of the transition requires a separate supporting structure (pipes are not self-supporting by their design), as well as thermal protection.

When laying on slopes and with a permissible slope, it is necessary to protect the area of the pipeline from washing away soil with water. For this, concrete or clay gates are built (**Figure 22**). This will also prevent longitudinal displacements.

4.10 Pipeline installation in difficult conditions

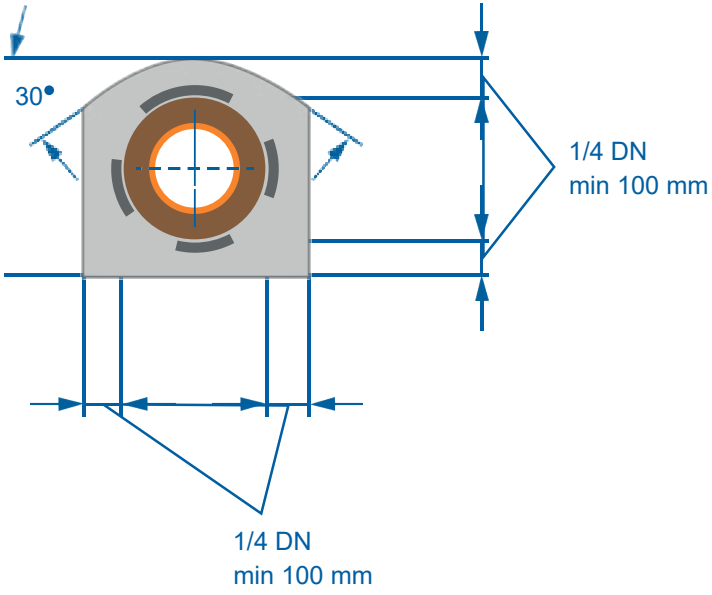


Figure 23.
Concrete cladding of plastic pipes.

When laying pipelines on steep slopes if it is impossible to implement the permissible slopes (more than 30% in any case), it is necessary to pave pipeline with drops (steps, steps) of the trench. At the same time, it is necessary to withstand slopes within the permissible limits. This also applies to bypass channels.

The pipeline concreting process must be carried out in a dry trench. In the case of soi water in the trench must be drained. The trench must remain dry until the concrete sets. Before creating the concrete cladding, it is necessary to check the connections for tightness. After this clearance check joints must be protected by self-adhesive tape from the penetration of cement mortar inside connection.

The concreted pipeline must be protected from possible leakage of concrete solution.

An example of concreting is shown in **Figure 23**.

4.10 Pipeline installation in difficult conditions

It is possible to concretize the pipeline along its entire length. But it should be used in exceptional cases. At the same time, it is recommended to separate the concrete cladding with expansion gaps at a distance equal to the length of the pipes, i.e. about 5 m. Expansion gaps must be placed on the pipe in the immediate proximity to the socket connection. These gaps are recommended to be made using fiber slabs.

The concrete solution along the entire length of the pipeline requires careful and careful compaction by laying the concrete mass in layers, tamping and, especially, tamping in the pipeline sinuses in a way similar to that used when pouring with sand.

After removing the fastening boards from the trench, the trench can be filled with native soil in layers with simultaneous compaction and possible removal of the formwork from the trench walls.

Concreting is carried out only after hydraulic tests.

When the pipeline passes through the wall, a wall passage corresponding to the pipe system used should be used (**Figure 24**).

Wall passage is used for inlet and outlet pipes, they are installed flush with the wall of the well and after the installation is completed, they are poured with concrete. Sleeves allow deviate the inserted pipe by 3°.

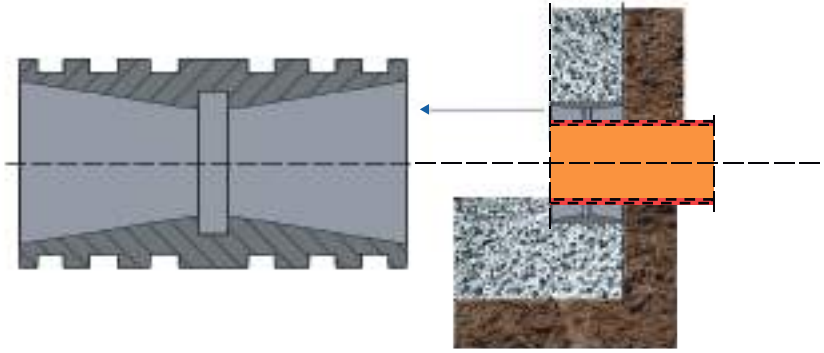
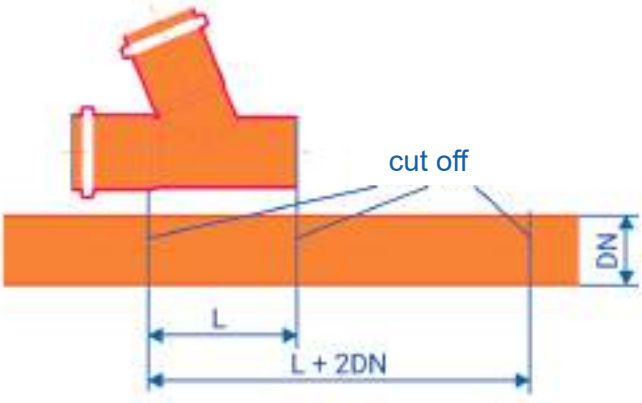


Figure 24. Wall passage

4.10 Pipeline installation in difficult conditions

If taps for additional connections were not provided during the laying, then they can be made later on the pipeline that is already in operation, using **3 methods**. Methods **2** and **3** are applied without a long-term stoppage of operation, and method **1** - with a short-term stoppage (overlap). In all in some cases, pre-prepared fittings corresponding to the pipe system are used.

Method 1 – installation of a tee. A fairly long section is cut out to establish a branch pipes – fitting length **+ 2 DN** (**Figure 25**). Chamfers are made on the cut ends of the pipeline, the surface is cleaned and a tee is installed. A suitable insert is made from the cut part of the pipe along the length, and is fixed with two push-on repair couplings on the pipeline.



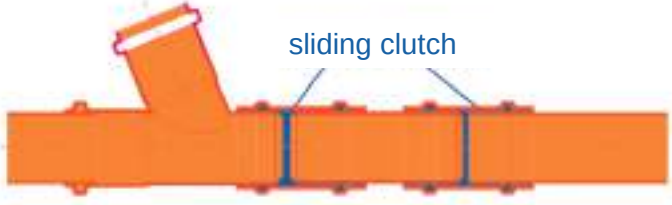


Figure 25. Installation of an additional tee

4.10 Pipeline installation in difficult conditions

Method 2 – installation of an overhead horn that is glued (**Figure 26**).

The sequence of installation of overhead bell:

- marking of the hole on the already laid pipeline according to the template or attached element to pipes through the bell;
- marking of the outer border of the surface to be glued;
- cutting a hole with an electric jigsaw and cleaning burrs with a knife or file.
- cleaning the outer part of the **PVC U** pipe, on which the overlay will be glued, and the inner side pads with a cleaning agent recommended by the manufacturer;
- application of the connecting glue recommended by the manufacturer on the surface;
- installation of a cover with a bell on the pipe within **30-60 seconds** after applying the glue;
- clamping of the lining with smoothly tightening clamps or hose clamps.

The adhesive joint cannot be subjected to mechanical stress for 15 minutes. You can clamp remove in about **1 hour**. In cold, wet weather (at a temperature below 10°C), this time is appropriate increases.

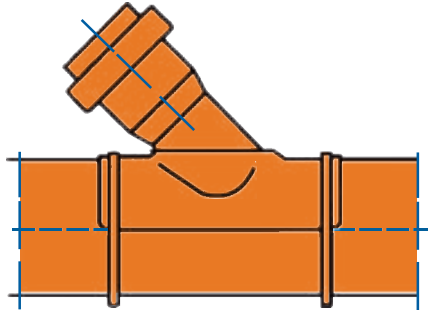


Figure 26.
Adhesive pad with bell

4.10 Pipeline installation in difficult conditions

Method 3 – installation of the insert (**Figure 27**).

To install a cut-in in the pipe in accordance with the conventional diameter of the pipe to be connected, it is necessar cut a hole with a drill bit perpendicular to the axis of the pipe. Then clean the edges from burrs and insert the insert. Tighten the nut counter-clockwise with the special key supplied in the kit. When the locking knurled nut is tightened, the sealing ring is compressed and provides a strong, watertight connection between the pipe and the insert.

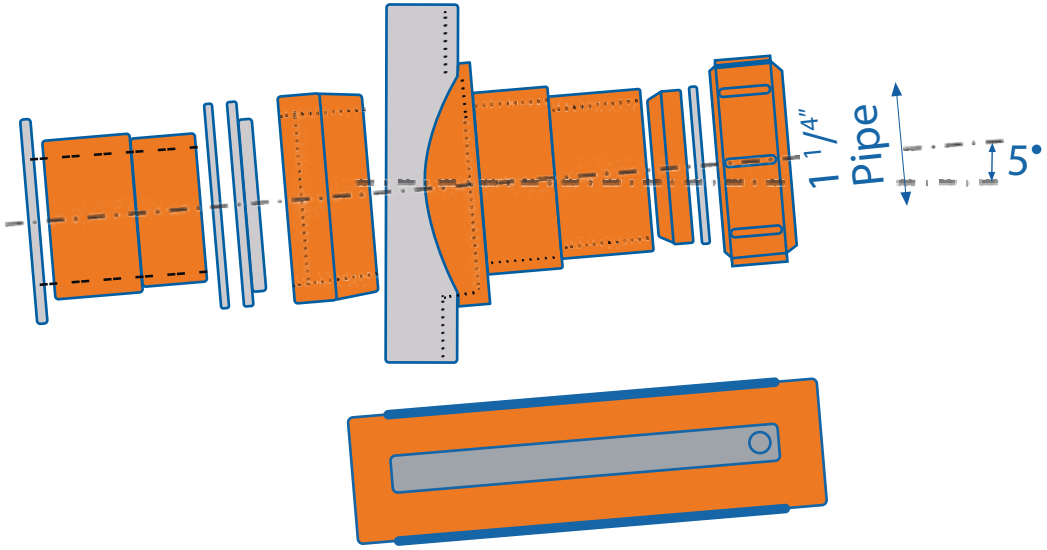


Figure 27. Cutting into a sewer pipe and a special key

4.11 Hydraulic tests

Before the pipeline is completely backfilled, hydraulic tests must be carried out.

It is possible to conduct tests of sections of the pipeline, the entire pipeline or individual pipe connections.

All openings of the inspected pipeline section, including branches and junctions must be closed waterproof and pressure-resistant plugs, and ensure that they cannot be squeezed out.

It is recommended to hammer the pegs and fasten all the fittings to them or install the appropriate fastening collars in such a way as to prevent the fittings from changing their position.

On straight sections, it is also necessary to fix pipes and control plugs at the ends of the pipeline frompressure forces acting in the horizontal direction.

To prevent the pipeline from changing its position, it must be fixed. In the presence of protective of the soil layer, the places of sockets and other connections must be accessible. Fill the pipeline with water so that so that there is no air left in it. To do this, slowly pour water into the lower point of the pipeline so thatso that the air accumulated in the pipes comes out in places for its release at the highest points of the pipeline.

At the same time, the filled pipeline cannot be connected directly to the pressure line (for example,through a hydrant). The pipeline must be filled with a free supply of water through an equalization tank installed on the pipe for filling or in a well with joint control of the socket connections of the pipeline andsocket connections of the well.

Sufficient time (1 hour) must elapse between filling and testing the pipeline so that the air, what remained in the pipeline after filling could gradually flow out.

The test pressure is measured at the lowest point of the tested area. Non-pressure pipelines must to be checked with an excess pressure of 0.5 atm. The test pressure, which is created at the beginning of the tests, shall be maintained by adding water for 30 minutes. At the same time, the amount of water added must be measured.

The test is passed if the volume of water added in 30 minutes is no more than:

- 0,15 l/m^2 for pipelines and channels;
- 0,20 l/m^2 for pipelines and channels with wells;
- 0,40 l/m^2 for wells;

where m^2 – is the area of the inner surface of pipes, fittings and wells (wetted area).

4.12 Protection of PVC U pipelines from freezing

The lining of the pipeline cover in the trench should protect against the freezing of drains. The depth of laying the sewage pipeline, thus, depends on the depth of soil freezing hz for this territory.

The depth of laying the pipeline should be such that the cover hn from the top of the pipeline toof the surface of the territory was greater than the depth of soil freezing hz by 0.2 m and was:

- in the zone with hz = 0,8 m – hn = 1 m;
- in the zone with hz = 1 m – hn = 1,2 m;
- in the zone with hz = 1,2 m – hn = 1,4 m.

In justified cases, it is allowed to reduce the cover hn, but not more than 0.1 m. Installation pipes and wells above the freezing depth and in places where the temperature drops below 0°C, it is possible with proper use of thermal insulation.

In each case, when installing pipes in permafrost, it is necessary to perform thermal engineering calculations anddetermine the thickness of the necessary insulation and the need for additional heating.

The main method is the use of a protective cover made of foam plastic, laid over the sewage pipeline (**Figure 28**). A simpler and faster way is to install an insulated pipe with a system accompanying heating.

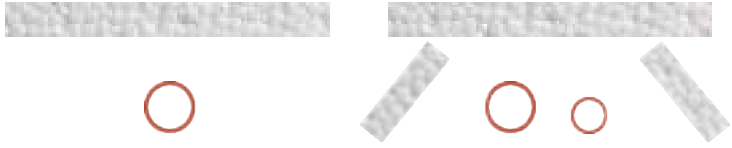


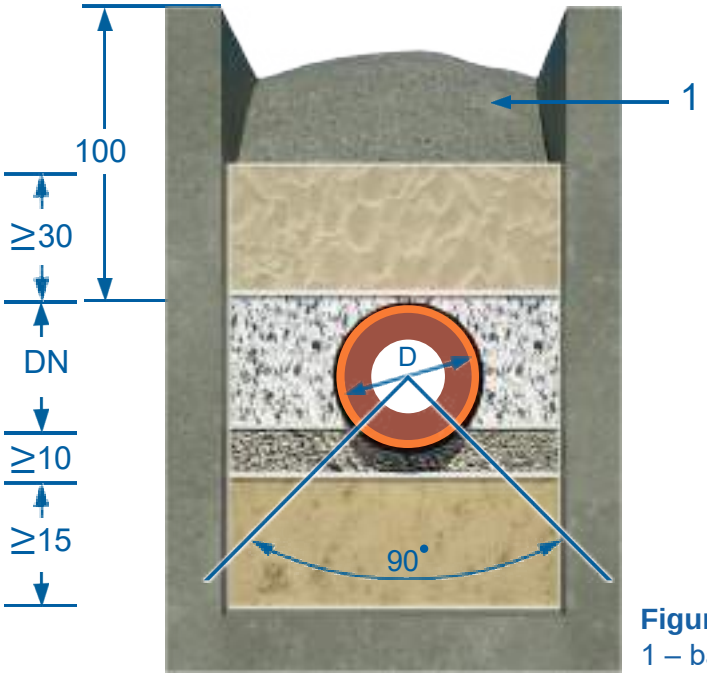
Figure 28. Thermal insulation of the pipeline using foam plates

The purpose of protection against freezing or thermal insulation is to reduce the heat transfer of the pipe to the surrounding space.

4.13 Final filling of the trench

During the final filling in areas of traffic, suitable for sealing materials. At the same time, the backfill must be compacted to **90%** of the maximum value.

Excavated soil can be used for filling outside the traffic area.If the final fill is not compacted outside the traffic area, the fill settles is compensated by increasing the height of the level at the place of excavation of the trench (**Figure 29**).



To the granulometric composition final filling (backfilling) the following requirements apply:

- in a layer **1 m** thick from the top of the pipe there should be no stones or debris in diameter more than **300 mm**;
- the maximum permissible particle size is **2/3** of the thickness of each layer, which compacted;
- the material must be a mixed structure, to avoid the formation of voids and penetration of permafrost.

Figure 29. Filling the trench
1 – backfill with a raised height in the place of the trench

4.13 Final filling of the trench

Directly above the pipe, compaction can be performed mechanically only when the thickness of the initial backfill above the pipe increases to 0.3 m (**Figure 30**).

The quality of compaction is influenced by the granulometric composition of the material, its moisture content, layer thickness, equipment, number of seals and temperature. This procedure is performed until the trench is filled or until at the moment of formation of a layer with a thickness of at least 0.9 m above the top of the pipe. The remaining filling of the trench is compacted with the help of an excavator or other construction equipment.

The removal of fasteners from the walls of the trench must be carried out with the simultaneous observance of precautionary measures, taking into account the danger of the edge of the trench collapsing.

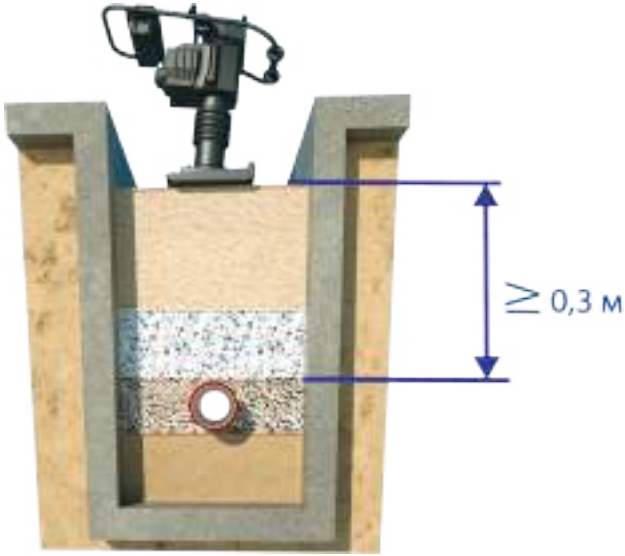


Figure 30. Mechanical tamping

The degree of compaction must correspond to the static data calculations of pipelines.

Choice of compaction devices, number of processes compaction and the thickness of the compacted layer should to match the compacted material (**table 10**).

Table 10. Soil compaction classes

Compaction classes			V 1			V 2			V 3		
Device		Operating weight, kg	Soil classes (DIN 18196)								
			GW, GI, GE, SW, SI SE, GU, GT, SU, ST gravel, sand-gravel mixtures, wide-grain sand-gravel mixtures (particles more than 0.063 mm from 5 to 15% by weight, more than 2 mm - more than 40% by weight)			GU*, GT*, SU*, ST* sand and gravel mixtures, sand mixtures (particles more than 0.063 mm from 15 to 40% by weight, more than 2 mm - more than 40% by weight)			UL, UM, TL, TM low plasticity and medium plasticity silt (lumps up to 50 mm), low plasticity and medium plasticity clay (lumps up to 50 mm)		
			Suitability	Filling height, cm	Number of transitions	Suitability	Filling height, cm	Number of transitions	Suitability	Filling height, cm	Number of transitions
1. Lightweight compaction equipment (mainly for the sprinkling layer)											
Vibro-rammer	light	до 25	+	до 15	2 – 4	+	до 15	2 – 4	+	до 10	2 – 4
	average	25 – 60	+	20 – 40	2 – 4	+	15 – 30	3 -4	+	10 – 30	2 – 4
Explosion-rammer	light	до 100	•	20 – 30	3 – 4	+	15 – 25	3 – 5	+	20 – 30	3 – 5
Planar vibrator	light	до 100	+	до 20	3 – 5	•	до 15	4 – 6	-	-	-
	average	100 – 300	+	20 – 30	3 – 5	•	15 – 25	4 – 6	-	-	-
Vibratory roller	light	до 600	+	20 – 30	4 – 6	•	15 – 25	5 – 6	-	-	-
2. Medium and heavy compaction equipment (backfill)											
Vibro-rammer	average	25 – 60	+	20 – 40	2 – 4	+	15 – 30	2 – 4	+	10 – 30	2 – 4
	heavy	60 – 200	+	40 – 50	2 – 4	+	20 – 40	2 – 4	+	20 – 30	2 – 4
Explosion-rammer	average	100 – 500	•	20 – 40	3 – 4	+	25 – 35	3 – 4	+	20 – 30	3 – 5
	heavy	500	•	30 – 50	3 – 4	+	30 – 50	3 – 4	+	30 – 40	3 – 5
Planar vibrator	average	300 – 750	+	30 – 50	3 – 5	•	20 – 40	3 – 5	-	-	-
Vibratory roller	average	600 – 8000	+	20 – 50	4 – 6	+	20 – 40	5 – 6	-	-	-

+ = recommended; • = most suitable

The data shown here are average values. Under unfavorable conditions (for example, relatively high moisture content, strengthening the walls of the trench), a lower fill height may be required, while under particularly favorable conditions it may be increased. Accurate values can only be obtained by trial compaction.

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