Construction of **Sewage Network and Waste Water Treatment Plant (WWTP) in Berane**

Volume 3-2 Technical Specifications

Section 2 Technical Specifications for Works

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# Provision of Temporary Facilities

## Temporary Diversions of Utilities

If in the opinion of the Contractor and Engineer it is necessary to make temporary diversions of any services in connection with the Works, the Contractor shall arrange after written approval by the Engineer with the relevant authority for the construction of those diversions.

The Contractor may at his own cost and subject to the approval of the authority concerned, make such temporary diversions as may facilitate the carrying out of the Works. If the Authorities request that any services shall be temporarily supported then the Contractor shall provide the necessary supports in a careful manner in accordance with the request and full satisfaction of the Engineer. If a decision is made to relocate permanently the services mentioned above by the relevant Authorities, the Contractor shall render every help to the Authorities including the removal of the road surfacing, excavation and, on completion of the works, reinstatement of the working area. The Contractor shall submit for approval full particulars, including drawings of any of the site installations and Temporary Works. If required the Contractor shall also submit calculations of the stresses, strains and deflections which will arise in false work or other Temporary Works and these calculations shall be accompanied by detailed Working Drawings to show the Contractor's proposals. Approval by the Engineer of the Contractor's proposals, calculations or drawings shall not relieve the Contractor of any of his duties or responsibilities under the Contract. It shall be the Contractor’s responsibility to handle, maintain, support and reinstate all the remaining services encountered to the full satisfaction of the Engineer and the relevant authority. The Contractor shall indemnify the Employer and shall be responsible for all claims whatsoever arising from any damage, injury etc. caused to the services as a result of his construction activities associated with this Contract.

## Provision of Temporary Services

When the execution of the Works requires the temporary disconnection of existing public or domestic utilities, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services.

1. For water supply he shall install temporary lines or arrange for regular supply by tankers.
2. When the Contractor is forced to disconnect power or telephone connections the relevant authority shall provide temporary connections at the Contractors expense. Upon completion of work the Contractor shall replace all severed connections, with the assistance of the concerned authority where necessary, and restore to operating order the existing facilities. Temporary facilities shall be provided by the Contractor, only for as long as required after which he shall dismantle and remove the same from their place of use as speedily as possible. Re-usable components shall be safely stored by the Contractor in his stockyard.

No valve or other controls in public service facilities shall be operated by the Contractor without approval of the Engineer and the relevant authorities. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored. Notwithstanding approval by the Engineer of any design for the Temporary Works, the Contractor shall be entirely responsible for their efficiency, security, and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract. All temporary diversions of utilities and provision of temporary services shall be covered by the lump sum amounts indicated in BoQ.

## Detours and Traffic Control

The Contractor of this Work has to deal closely with the Engineer in order to streamline the works in public roads and to minimise any detour of traffic and to reduce the nuisance to the public. The Contractor shall seek information on and comply with all requirements and recommendations of the police regarding traffic arrangements and road safety measures. The Contractor shall provide all barriers and traffic sign as required by the Authorities.

The access rights of the public shall be considered as important at all times. Unless otherwise authorised by the Engineer, Police or District Traffic Commission, the Contractor shall not obstruct traffic passing through streets and thorough fares on which the Works are being carried out unless an approved detour is provided. The Contractor shall program his work in such a way that, wherever the temporary closure of street sections to public thoroughfare cannot be avoided, the duration of traffic diversion can be kept as short as possible. No streets shall be closed and no detours shall be introduced and no traffic diverted until the Contractor's proposals have been approved by the Engineer and the appropriate authorities, such as the Police Department of Berane. Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, houses, commercial and industrial establishments, churches, mosques, schools, parking bays, service stations, hotels, fire and police stations, hospitals, and establishment of similar nature. Access to above mentioned places and areas shall be continuous and unobstructed unless otherwise approved by the Engineer. Safe and adequate pedestrian zones and public transportation stops, as well as pedestrian crossings of the Works at intervals not exceeding 100 m, shall also be maintained unless otherwise approved by the Engineer. During construction of the sewers the Contractor shall provide and maintain mobile pedestrian trench crossing planks with a sturdy build. Mobile pedestrian trench crossing planks shall have guardrails. On instruction of the Project Manager or the Employer’s site supervisor mobile pedestrian trench crossing planks may have to be repeatedly relocated.

To permit the passage of pedestrian, vehicular and other traffic the Contractor shall phase the excavation, pipe laying, jointing and reinstatement in such a way as to provide reasonable access to houses, roads, footpaths etc.

Vehicular access to driveways of residential properties shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has been completed to such an extent that safe access can be provided and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access. The site shall be limited to that necessary to construct the Works as approved by the Engineer. Where work is to be carried out in public roads, the Contractor shall give notice to the Engineer sufficiently in advance of the date on which he wishes to commence such work in order to optimise the works in public roads and to avoid any inconvenience to the affected traffic as well as to the inhabitants.

Detours shall be selected in such a way that the inconvenience to the affected traffic as well as to the inhabitants of the affected areas is kept to a minimum. The Contractor shall be responsible for obtaining the permission of the Engineer and the Police for activities he intends to carry out in public roads. Three copies of the Contractor's proposals to the relevant authorities shall be submitted to the Engineer. One copy of all obtained approvals shall be submitted to the Engineer. The Contractor's attention is drawn to the fact that processing of the documentation required by the local authorities prior to the cutting of existing public roads takes at least 30 days. All traffic signs and control devices to be furnished and installed by the Contractor shall be approved by the Engineer for their location, position, visibility, adequacy and manner of use under specific job conditions. Particular attention has to be paid for the traffic control by night. All traffic control devices necessary for the initial stage of construction shall be properly placed and operational before any construction is allowed to start. When work of a progressive nature is involved, the necessary signs shall be moved concurrently where they are needed. If the Engineer determines that proper provisions for safe traffic control are not being provided or maintained, he may restrict construction operations affected by such defective signs or devices until such provisions are established or maintained, or may altogether order suspension of the Work until a proper traffic control is achieved. In case of serious or will full disregard by the Contractor of the safety of the public or his employees, the Engineer may take necessary steps to rectify the situation and deduct the cost thereof from monies due or becoming due to the Contractor. The Contractor shall be responsible for all resulting delays. The Contractor shall designate or otherwise employ personnel to furnish continuous surveillance of the traffic control operations. The designated personnel shall be available day and night to respond to calls involving damage due to vandalism or traffic accidents. At sections where traffic is in operation and when ordered by the Engineer, the movements of the Contractor's equipment from one place of work to another shall be subject to traffic control. During rush hours movement of larger vehicles, such as trucks, cranes, dumpers, etc. through main thoroughfare are not permitted by the police. Spillage resulting from hauling operations along or across the road way shall be removed immediately at the Contractor's expense.

The Site shall be furnished according to the national traffic regulations with the required traffic signs, guide boards, protection and security installations. The Contractor shall maintain and illuminate the facilities, including the operational costs for the whole period of construction up to the opening for traffic.

Facilities for road blocking, traffic safety, illumination and signposting shall be provided for total and partial road blocking as well as for traffic restrictions in the construction area. Fees for permits from the public department for road issues shall be included.

Where required, the Contractor shall provide a set of temporary traffic lights with two traffic lights for traffic regulation in 3-phase operation “red-yellow-green” with a variable setting. The set of temporary traffic lights shall be fully automatic. Depending on the work progress, a repeated relocation of the traffic lights may be required. Signposting of the streets shall be as stipulated by the police. Operational and electricity costs and the power supply connection shall be included.

For the maintenance of the traffic flow during the complete construction duration temporary traffic ways shall be constructed. Before start of construction the Contractor shall prepare a traffic plan for the temporary traffic ways and obtain the permit from the public department for road issues. To reinstate the original state of the site temporary traffic ways shall be removed after completion of the works, including all supplementary works.

The Contractor shall deliver traffic routing plans, all carrying the approval of the representative of the municipality, for the installation of pipes and manholes in main roads, along bridges, for crossing of the roads, railways, etc.

# Demolition and Alterations



## General Requirements

The demolition of structures includes the demolishing of all kinds and grades of bricks, wooden structures, plain concrete and reinforced concrete, pipes, all requisite shoring and strutting or other supports incidental to demolition works, the removal of debris from site, final site clearance and making good of disturbed parts.

The demolition works to be carried out under this Contract on the sites for constructing the Works may comprise water lines, sewers, conduits, manholes, walls, fences and pavements.

Before moving equipment into the Site and commencing operations the Contractor shall establish to the Engineer's satisfaction that the method of demolition proposed by the Contractor is such that he can ensure the safety of structures adjacent to those to be demolished.

All materials arising from the demolition and clearance of water lines, sewer network lines, buildings, structures and other objects mentioned above shall become the property of the Contractor and shall be disposed off site. Disposal of the material shall be according to the respective regulations. Disposal certificates need to be presented.

Where required or directed by the Engineer, the existing structure will be temporary reinforced to assure the stability. The Contractor will submit for the Engineer's approval the methods applied for demolishing and the proposed temporary safety measures. The Engineer's approval shall not relieve the Contractor of any of his responsibilities under the Contract.

# Setting Out

Prior to the commencement of excavation for any particular sewer line it shall be the Contractor's responsibility to accurately set out the route of every pipeline in accordance with Drawings before commencing construction. The route of the sewer line shall be clearly marked on the ground and ground levels have to be taken where required by the Engineer. The Contractor shall establish and maintain centre line, chainage and level reference points to the satisfaction of the Engineer.

The setting out must be approved by the Engineer. Setting Out must minimum be made in accordance with standard BS EN 1610.

The Contractor shall be obligated to ascertain for himself the existence of any bench marks and/or boundary demarcations on Site and shall proceed with the setting out of the Works having physically checked any levels, dimensions and information given by the Engineer.

Before carrying out any work at any location, the location shall be inspected where necessary together with the Engineer. The Contractor shall request in writing such inspections where in his opinion the situation shown in the Drawings has changed and/or is different from actual conditions.

The Contractor is responsible for the transfer of line and grade from control points established by the Engineer. The preservation of stakes or other line and grade references provided by the Engineer is the responsibility of the Contractor. The Contractor’s method for setting the line and grade for the activities shall be approved by the Engineer.

# Clearance of Sites

Prior to the commencement of any excavation work, the Contractor shall clear the site and remove all kinds of rubbish, shrubs, general vegetation, etc. Where so ordered, the Contractor shall remove and conserve the topsoil for later use in a manner approved by the Engineer.

The extent of Contractor’s clearing and grubbing operations shall be the minimum practicable necessary in the opinion of the Engineer for the construction of the Works. Costs of all these works shall be assumed to be included in the rates and prices or as expressively stipulated in the respective items in the BoQ and no extra payment shall be done to the Contractor.

All vegetation, trees, etc. arising from the clearing and grubbing operations shall be dumped at a depot to a location directed by the Engineer. Remnants of vegetation, including trees, stumps and roots, shall be disposed off site by the Contractor unless otherwise directed by the Engineer.

# Protection of Existing Services



## Protection of Overhead and Underground Services

Having identified the proposed sewer line route, the Contractor shall liaise with the utility companies before commencing any excavation. Any instructions given by these utilities shall be followed. With the assistance of the utility companies the Contractor shall satisfy himself as to the exact location of all existing underground services which may affect or be affected by the excavation of the sewer line.

The Contractor is responsible for identifying the exact location of these services, by inquiring and inspecting all the records available from the appropriate Authorities. No responsibility will be assumed by the Employer for the correctness or completeness of the Contractual Drawings concerning the existing utilities and if such information be found incorrect or incomplete. The Contractor shall have no claim on that account. During excavation, the Contractor shall be responsible for protecting, supporting, removing or relocating all utilities that may be damaged due to the works.

Before proceeding with any action relating to existing utilities, the Contractor shall notify the authority concerned in writing. In all cases he shall co-operate fully with the authorities and follow their instructions concerning protection, removal or relocation. All protection and relocation work shall be carried out in accordance with the standards of the relevant authority, including the maximum length of the utility which can be left exposed and supported before it is necessary to provide for relocation. No payment will be allowed for delay to the Contractor's operations due to the inconvenience caused by identifying, protecting, supporting removing or the relocation of these services. The Contractor shall therefore include in his tendered prices all costs involved because of these services whether due to the inconvenience caused by them or any necessary rescheduling resulting from delays.

If damage occurs due to the Contractor's operations, even though special precautions have been employed, the Contractor shall be entirely responsible for such damage whether such operations and the work resulting from there have received the prior approval of the Engineer or not and all such damage shall be satisfactorily rectified at the Contractor's expense. The Contractor is not entitled to any extra payment or extension of time, due to problems arising from the matters mentioned above. All possible expenses should be included in the unit rate of excavation given in the Schedule of Prices. The Contractor may, at times be requested to permanently relocate existing utilities at the request of the Employer. In such cases he will receive written instructions from the Engineer specifying the relocation work to be carried out. The Contractor will be compensated for any additional work related to this type of utility relocation at the day work rates given in the Schedule of Prices for labour, materials and equipment (Volume 4).

The Contractual Drawings show positions/location of existing underground services based on the best information available.

The Contractor is required by his own enquiries, investigations and actions to satisfy himself as to the sufficiency and position of any utilities.

Where underground services can reasonably be inferred, the Contractor shall, in collaboration with the Engineer, ascertain by detection equipment (Ground Penetration Radar (GPR), pipe locator, etc.) on his costs whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Engineer to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction activities commences.

As soon as any buried service is discovered, it shall be deemed to be a known service and the Contractor will be held responsible for any subsequent damage to it. If such a service is damaged during the course of its discovery, the cost of making good such damage will be borne by the Contractor only. The Contractor will be held responsible for any damage to known services (i.e. above ground services that are visible within the Site and underground services) and he shall take all necessary measures to protect them.

The Contractor shall excavate any trial holes he may require to determine the position of underground services. Such exploratory excavations shall be carried out in consultation with the Authorities concerned and either be protected until the general excavation meets this excavation or be re-filled after recording the nature and position of the service according to the Engineer’s instructions. He shall not use mechanical equipment to excavate within 3m of the assumed position of any service and shall expose the service by means of hand excavation carried out under proper supervision. When so ordered, the Contractor shall backfill such observation trenches with approved material to the compaction density ordered. Once a service is exposed the Contractor shall take all measures necessary for the support and protection of the service. Where a service is damaged because of the Contractor's negligence, he shall inform the Engineer and the authority concerned make good such damage or bear the cost of the repairs, as applicable.

All underground services found need to be reported to the Engineer.

For the complete construction duration existing cables and pipes shall be secured and supported. Cables, cable bundles and pipes, which are running parallel in the pipe trench, shall be supported safely. Possible existing cable conduits or similar shall be temporarily removed and stored on the Site. After completion of the works, cables, pipes and cable conduits shall be reinstated and marked with a cable warning tape. All work or protective measures shall be subject to approval of the Engineer. Costs for securing, removing and reinstating of exiting service lines shall be included in the unit prices. In the event of a service being damaged he shall inform the Engineer and the concerned authority immediately. The Contractor shall not repair any such service unless instructed by the Engineer to do so.

Where water supply lines cross sewer mains with a clearance of smaller than 0.20 m or where the clearance between parallel pipes is smaller than 0.40 m a protection pipe around the water supply pipeline shall be installed at no additional costs. At pipe crossings the protective pipe shall extend at least 1.00 m to both sides of the sewer pipe.

# Earthworks



## Topsoil

Where applicable, for the excavation of trenches and building pits the layer of topsoil (average thickness: 30 cm) including grass, shrubs and similar shall be removed and separated from the excavation of the deeper layers. For reuse the topsoil shall be temporarily stored on the construction site.

After refilling of trenches and building pits the Contractor shall transport the topsoil and fill the layer of topsoil in the required thickness on sloped and horizontal surfaces on the site.

The work includes transport on site and intermediate storage of soil on stable and well drained stockpiles within the area affected by construction operations. Topsoil shall be stockpiled in a manner to prevent its deterioration. Topsoil shall include any surface material capable of supporting vegetation and suitable for use in soiling areas to be grassed or cultivated. The Contractor shall not dispose of surplus topsoil without the written permission of the Engineer. The cost of this shall be assumed to be included in the rates and prices and no payment shall be done.

## Excavation

Prior to commencing any excavation the Contractor shall obtain relevant excavation and road cutting permits as required to commence the work from service providers, the town hall and traffic police. The Contractor shall liaise with the town hall; traffic police and service providers to determine the number of permits required and shall ensure they are obtained in accordance with the works programme.

The Contractor shall apply for such permission, giving notice in writing to the Engineer and the relevant authorities of his intentions to excavate in sufficient time to enable the necessary procedures and approval to be executed. He shall liaise with the relevant authorities with respect to the programming and execution of the crossing.

The Employer and the Final Beneficiary shall not be liable for any penalties imposed by the relevant authorities for delays from the deadlines provided in the excavation authorizations.

Trenches and manhole pits shall be excavated as specified in the standards (i.e. DIN 4124, DIN EN 1610). The pipe trench for the sewer shall be true to profile. Bottom width of trench shall be according DIN EN 1610 as required for the nominal pipe diameter (see table below). Depth of trench and depth of manhole pits shall be as indicated in the drawings.

|  |  |  |  |
| --- | --- | --- | --- |
| **Minimum trench width in relation to the nominal pipe diameter DN** | | | |
| DN | **Minimum trench width** (OD + X) | | |
|  | Trench with shoring | Trench without shoring  β > 60° | Trench without shoring  β <= 60° |
| <= 225 | OD + 0,40 | OD + 0,40 | OD + 0,40 |
| > 225 to <= 350 | OD + 0,50 | OD + 0,50 | OD + 0,40 |
| > 350 to <= 700 | OD + 0,70 | OD + 0,70 | OD + 0,40 |
| > 700 to <= 1200 | OD + 0,85 | OD + 0,85 | OD + 0,40 |
| > 1200 | OD + 1,00 | OD + 1,00 |  |
| X/2 corresponds to the minimum work space between pipe and trench wall respectively trench shoring  OD - outside diameter of pipe, in m β - angle of slope of the trench wall, measured from the horizontal | | | |

Pipe trenches shall be excavated to the typical cross-sections shown on the Drawings. The Contractor shall ensure that at any point the width of the pipe trench is sufficient to permit the sewer line to be laid, jointed, bedded/surrounded and backfilling, to be placed and compacted around the pipeline to the Engineer's satisfaction. The trench invert shall, at any location, be at the proper level and trench width of the proper dimensions to allow for gravel, sand and/or concrete bedding or surrounds as shown on the Drawings and directed by the Engineer. Should any part of a trench be excavated, in error, deeper than required, the Contractor shall fill in the trench with suitable material or Concrete Class C15, to meet the required levels, at his own expense. Where welding or jointing of pipes and/or accessories is required to be done in the trench, the trench shall be widened and/or deepened to form bell-holes. This enlargement must easily permit the proper execution of all welding, connecting and fixing work in all their stages, all necessary repairs to the pipe and coating, and the thorough inspection of all these operations. Trench formations shall be in undisturbed ground.

Excavated soil is rated class 3 – 7. Boulders and other materials bigger than 25 cm diameter shall be collected and disposed off on the expenses of the Contractor. All works for additional hollows at pipe connections and excavation for the manholes shall be included in the unit prices.

Suitable excavated soil for the backfill of the trench and sub-base (between surround and macadam/gravel road base) shall be transported to an intermediate storage on the Site. Excavated excess soil shall be removed immediately from site at the Contractors’ expenses.

Special attention is drawn to the fact that the soil may be contaminated by raw or partially treated sewage which has leaked from tanks, pipes, etc. All costs associated with the removal of material from the site and with the disposal of the excess soil at suitable disposal sites shall be considered to be included in the unit rates for trench excavation.

As preparation for the underlay (pipe bedding) the subgrade at the bottom of the trench shall deviate not more than 2 cm from the specified excavation depth. The subgrade shall be trimmed by hand immediately prior to the laying of pipes. No work shall be started on the laying of pipes or bedding in any section of trench, until the trench formation of that particular section has been approved by the Engineer.

Included in the price for excavation shall be the crossing under property enclosures (walls, fences, etc.) up to a height of 1.50 m. All hardships associated with the excavation, trench shoring, pipe laying and refilling are deemed to be included in the price.

## Trench shoring

During the excavation of trenches, the Contractor shall use trench shoring on both sides and at begin and end of the pipe trench at all depths, which are bigger than 0.90 m (except in cohesive soil and rock).

The Contractor shall take all necessary precautions during the excavations to protect his workmen and the public. The sides of excavations shall be supported whenever necessary by means of timber, steel or other type of struts, walling, boards, sheeting or any other approved system. These shall be provided by the Contractor and shall be of proper design and sound construction.

## Pipe bedding

For a uniform foundation of the pipe, the Contractor should provide a layer of sand or gravel (maximum grain size as specified by the pipe manufacturer but no greater than 20 mm) in accordance to DIN EN 1610 in a thickness of 100 mm + 1/10 DN in mm. The minimum thickness of the pipe bedding on rock or solidly compacted soil types shall be 150 mm. Each and every pipe shall be supported evenly throughout its entire length.

Granular bedding for pipes shall be formed by spreading and compacting material over the full width of the trench. Sufficient granular material shall be provided to allow the pipes to be worked into the granular material and firmly supported to true line and level. Sufficient space shall be left to enable the joints to be made, tested and inspected and the Contractor shall ensure that at least three quarters of each pipe length is fully supported.

Provision of the bedding layer includes compaction by hand to a degree of compaction of at least 95 %. The bedding works shall be carried out in compliance with DIN EN 1610.

Cables and cable conduits shall be laid on a 100 mm compacted sand bed graded 0/2 mm and embedded by hand up to 150 mm above the top of the pipes in accordance to the methods prescribed for pipes.

## Gravel bed for manholes

Prior to the construction of the manholes the Contractor shall install a 20 cm thick gravel bed. A degree of compaction of 97 % is required. The Contractor shall carry out tests (i.e. plate load test acc. to DIN 18134) to verify the specified degree of compaction.

## Pipe zone backfill (surround)

After the pipeline has been tested and approved by the Engineer the trench shall be carefully filled with granular material.

The trenches shall be backfilled in layers as specified hereafter. Each layer shall be separately compacted and any subsidence resulting from insufficient compaction shall be the Contractor's liability and he shall forthwith add the necessary extra material, which shall then be thoroughly compacted.

Up to 30 cm above top of pipe the Contractor should fill up the trench with gravel or sand (maximum grain size as specified by the pipe manufacturer but no greater than 20 mm). The sand material and surround shall be wetted and thoroughly hand-tamped in layers not exceeding 15 cm in thickness after compaction. Special care shall be taken to obtain proper compaction around the pipe. This filling shall be carried out with the utmost care. The difference in level of backfill on either side of pipes shall not exceed a maximum of 0.15 m. Spreading and compaction shall be carried out evenly by a method approved by the Engineer without dislodging, distorting or damaging the pipe or the joints. Power rammers shall not to be used within 0.30 m above any part of the pipe or joint. Backfilling of pipe trenches, except at joints, shall be done as soon as practicable after the pipes have been satisfactorily laid in position, jointed and approved by the Engineer. No backfilling of trenches shall begin until the trench bedding, pipe laying, jointing and testing have been approved by the Engineer. The Engineer shall be given 24 hours advance notice of intent to backfill, in which time he will carry out his inspection.

A degree of compaction of 97 % is required.

The Contractor shall carry out tests (i.e. plate load test acc. to DIN 18134) to verify the specified degree of compaction.

Except in roadways and other paved areas, backfill of trenches shall be brought up to the natural ground level. Where topsoil is at the surface on the line of the trench, the upper section of the backfill shall be topsoil of the thickness described, or of the same thickness and quality of topsoil as the surrounding ground.

## Warning Tape

Not deeper than 60 cm below the final surface level, a plastic warning tape with location-wire according to DIN V 54841 –1 should be placed on the total length to protect the pipe and enable a later detection. Colour and inscription shall be according to the intended purpose. The warning tape shall be of intensive brilliant colour and 40 mm wide.

## Backfill of Manholes

After construction of the manholes the Contractor shall supply and backfill the excavation pits with non-cohesive, compactable soil (soil class 3-4, sorting coefficient: U = 6 –10, Clay/Silt content (grain sizes < = 0.06 mm): max. 10%, free of slimy, perishable material or vegetable matter. The backfill shall be carried out in layers of 40 cm each. Each layer shall be thoroughly compacted by an approved mechanical compacter before each succeeding layer is placed. A degree of compaction of 97 % is required.

## Securing of existing fences and walls

During the construction works existing fences and walls shall be supported and secured.

Any kinds of foundations, which have been exposed during the earth works and put at risk to fall down, shall be secured and supported by choice of the Contactor, including all additional works.

## Protection of Existing Structures

The Contractor shall: protect benchmarks, existing structures, fences, roads, sidewalks, paving and curbs against damage from equipment and vehicular traffic.

Any property situated in close proximity to the Works shall be protected against any damage which could be caused by vehicles, subsidence, vibration, etc. Any damage caused shall either be repaired by the Contractor or the Contractor shall pay for the works to be repaired to the condition of the property prior to damage and to the satisfaction of the Engineer. Around utilities as there are electricity pylons an area of 5m shall be kept free from site works unless there is necessity of construction works according to the design documents.

Construction works and trench excavation at utilities, along existing supporting walls, at dams and embankments shall be executed under strictly avoidance of settlements. Earth works or any other construction work close to existing structures or embankments as mentioned before shall be kept out of the sphere of earth static influence. This is defined by a borderline measured at the level at the soil surface that is attached to the structure or the bottom of the embankment, 1 m horizontally away and then sloping down with 45°. For such kind of works necessary approval of the relevant authorities shall be taken. For all work that interferes with this line the Contractor shall provide static calculations that have to be approved by an independent Consultant. The Contractor has to apply a suitable method for pit/trench sheeting and bracing with low vibration and low concussion.

## Securing of existing light posts and traffic signs

Light posts, indicator and traffic signs, which are located in the route area and are endangered in their stability for the duration of the sewer works, shall be supported and skilfully secured against collapse and subsidence.

The Contractor shall re-install any road furniture (such as street lighting, traffic sign or traffic lights) that has to be removed during the execution of the Works. Installation of the road furniture shall take place at its original location, in a condition at least equal to that prior to removal and as soon as practicable after completion of pipe laying at a particular location.

## Protection of Trees

Trees shall be protected against mechanical damage by use of an approx. 2,00 m high vertical planking with approx. 10 cm thick upholstery between tree and planking of appropriate material (pressed straw, mattresses or similar).

Roots of trees shall be protected during excavation in roads. In the proximity of trees the Contractor shall comply with and take action according to DIN 18920 “Protection of trees, plants and vegetation during construction” and “Guidelines for road construction”, part Landscaping (RAS-LG 4). In the proximity of roots manual excavation shall be used. Severed and crushed roots shall be treated according to DIN 18920. Damages of main roots shall be exposed and treated professionally. Exposed roots shall be secured and protected from drying-out by use of wet cloths or bags.

## Dewatering

The Contractor shall keep all excavations free from water whatever source whether caused by ground water, tides, floods, and storms or otherwise so that the Works shall be constructed in dry conditions. The Contractor shall keep the sub-soil or accumulated water at a level lower than the bottom of the Permanent Works for the complete construction period. All construction operations being performed shall be free from standing water, unless otherwise specified, and will result in all foundations being sufficiently dry for proper bonding of the backfill materials with the foundations and proper compaction of the materials placed. The Contractor will be required to control any seepage along the bottom of the foundations or elsewhere and prevent the accumulation of standing water. Generally dewatering at foundations shall comply with the requirements of DIN 4095.

The Contractor shall provide dewatering of the pipe trench and the manhole pits, including pump sumps, the complete dewatering equipment (pumps, pipelines) and appurtenances. To be included are maintenance, operation, control and servicing of the plant for the complete construction period. If required, permission for the discharge of the water into the storm water and sewer system or into rivers shall be obtained.

The Contractor shall provide and maintain and operate dewatering or other pumping plant to remove water from the excavations, and shall prevent water entering the excavations.

Water in the excavations shall be dealt with in such manner as will prevent the surfaces on or against which foundations or other work will be constructed from any deterioration of their natural condition, or from such condition as improved by work executed under the Contract.

The Contractor shall ensure that disposal of water does not create a nuisance or cause damage. The Contractor shall ensure that sufficient stand-by equipment including power generator is available on site at all times to avoid any interruption to continuous dewatering.

Precautions shall be taken especially when ground dewatering equipment is used to ensure that lowering of the ground water table in the vicinity of excavations or the removal of fine particles of soil from the ground surrounding the excavations causes no damage to adjoining Works or property, or the ground consolidated previously by others. The Contractor shall take all necessary precautions to ensure the stability of any of the Works against flotation or displacement during construction due to high subsoil water level, flood or other causes. No separate payment shall be made for dewatering, and the costs incurred in this activity shall be included in his rates and prices for the Works the total cost of dewatering and keeping the excavations dry and secured from hydraulic uplift the construction as required by the Specifications. No additional payment for pumping, dewatering etc. necessary during the construction period will be certified by the Engineer.

# Continuation of wastewater discharge during construction

The rehabilitation of existing sewer lines will be executed under operation conditions. During any replacement or any construction work in the sewer system, the Contractor shall maintain the normal sewage flow until the connections to the new sewer system have been made. Interruptions of the sewage flow shall be kept to a minimum and should possibly be imposed during night in order to reduce the nuisance to the population.

The Contractor shall submit to the Engineer his detailed proposal accompanied with a schedule for maintaining the wastewater discharge. The Contractor’s method proposed for each location shall be subject to the approval of the Engineer. The proposal or method of the Contractor may be put into operation upon approval by the Engineer. However, such approval will not relieve the Contractor of his obligations under the Contract.

When forced to disconnect existing sewers the Contractor shall install temporary facilities of adequate size to carry off sewage from any private sewer facilities cut off by construction work. Connections to temporary pipes shall be made immediately by the Contractor upon cutting off the existing facility. No sewage shall be allowed to flow from any severed facility upon the ground surface or into the trench excavation.

The Contractor shall include the costs for the provision, operation, maintenance and removal of the required material and equipment (excavation, pipe plugs, pumps, pipelines, etc.) in the tender price.

Depending on the specific local conditions the Contractor shall provide for the continuation of wastewater discharge during construction by the following means:

* Temporary pumping of the wastewater through bypassing pipelines above ground outside of the pipe section to be reconstructed including:
* Construction of a temporary manhole and installation of a sewage pump for each sewer service connection
* Installation of two sewage pumps working in the same manner as in the main sewer
* Installation of a collection tank
* Connection of incoming sewer and pump facility
* Construction of (two) pressure pipelines for connection of pump manhole with the downstream sewer
* Discharge by gravity in pipes laid within the pipe section to be reconstructed.House connections shall be connected to this temporary pipe.

# Pipe works



## General

For the new sewers the Contractor shall furnish and install the complete pipes and fittings as required for the construction of the sewers according to the drawings.

The Contractor shall submit manufacturer's certificates and certificates from approved laboratories certifying that the pipes have been subjected to, and have satisfactorily undergone the required tests according to the specified standards. All materials shall comply with the standards mentioned hereinafter.

The Contractor shall proof the suitability of the pipes for the specific installation conditions in accordance with the Worksheet ATV-DVWK-A 127: Directive for the statistical calculation of sewage pipes and pipelines. The contractor shall make the calculation for each pipe diameter for all occurring pipe depth intervals (interval range shall not exceed 0.5 m) and for the different soil conditions and for other different conditions, which may vary due to working methods etc.

No works shall start until calculations have been approved by the Engineer. The calculations must be approved by the Engineer before production or ordering of pipes shall be executed. The contractor is fully responsible for his calculations.

Pipes shall be labelled according to DIN EN 13476, including: manufacturer mark and reference to the standard, pipe material, nominal diameter and stiffness class.

The pipes must be manufactured by an ISO 9001 certified company.

Transport, handling, storage and installation of pipes shall be in accordance with the pipe manufacturers’ instructions.

Pipe characteristics such as ring stiffness and ring flexibility will be tested. The Engineer reserves the right to select test samples from each delivery. Tests will be conducted in an independent and certified laboratory to be selected by the Engineer. The cost of samples, their transportation to the laboratory and their testing shall be deemed to be included in the unit rates and shall not be paid for separately.

The Engineer shall have the right to reject consignments or stocks of pipes from which failed pipes have been drawn. The Contractor shall remove pipes which failed the tests from the Site immediately and replace them with acceptable pipes at his own expense. Only pipes marked as accepted shall be incorporated in the Works.

In the section of the detailed design where the Bill of Quantities prepared by the Employer was based on corrugated polyethylene pipes according to DN/ID range whereas the nominal pipe diameter corresponds to the internal pipe diameter that was determined by a hydraulic calculation. If the Contractor intends to use pipes according to DN/OD range whereas the nominal pipe diameter corresponds to the external pipe diameter, then the corresponding external pipe diameters OD need to comply with the following table. For example, if the detailed design requires installing a pipe diameter of DN/ID 250, the corresponding external pipe diameter of the DN/OD range is OD 315.

|  |  |
| --- | --- |
| **Pipe diameter DN=ID acc. to detailed design and BoQ** | **Corresponding external diameter for pipe series  DN=OD** |
|  | de |
| 150 | 160 |
| 200 | 250 |
| 250 | 315 |
| 300 | 400 |
| 400 | 500 |
| 500 | 630 |
| 600 | 800 |
| 800 | 1000 |

Fittings unless otherwise specified shall be furnished with a type of joint compatible with the pipe system at the supplier’s option. Any adapter necessary to joint fittings to the adjacent pipes, even of different materials, shall be provided by the Contractor at no extra cost.

Costs of all joints, specials and fittings (shaft linings, branch pipe 90° with reduction, linking pipes, etc.) shall be included in unit costs for supply and laying of pipes. No extra payment shall be made for any joints and fittings.

## Corrugated polyethylene pipes



### Pipes and fittings

Corrugated polyethylene pipes and fittings shall be designed to DIN EN 16961, range 5 and prEN 13476 with the following class of rigidity and corresponding ring stiffness values (EN ISO 9969):

|  |  |
| --- | --- |
| Class of rigidity | Ring stiffness values |
| SN4 | minimum 4 kN/m2 |
| SN8 | minimum 8 kN/m2 |

Pipes and fittings shall be double wall; corrugated on the outside and smooth surface on the inside. Pipe couplings shall be with double push-fit socket and EPDM or oil-resistant NBR lip sealing rings. The thickness of the internal wall shall be suitable for high pressure jet cleaning systems (120 bar). Minimum wall thickness shall be according to prEN 13476. Material properties of pipes and fittings shall correspond to the requirements of prEN 13476. Ring flexibility (capacity for deformation without rupture) shall be at least 30 % according to EN 1446. Abrasion resistance shall be certified according to EN 295-3. Delivery pipe lengths shall be 6 m or 12 m.

### Transportation and storage

Pipes and fittings should be handled carefully and gently. In case of inappropriate transportation and wrong storage, deformations or damages can occur to the sewage pipes, fittings and sealing rings, which can lead to difficulties when laying the pipe and can affect the operating safety of the pipeline. Therefore the following instructions must be observed.

### Transportation

Pipes have to be supported over their entire length during transportation and they have to be secured against displacements. The stacking height of maximum 2.0 m has to be respected. Bending and shock stress should be avoided.

### Unloading

Appropriate devices (e.g. forklifts with wide fork overlays) should be used for the loading and unloading of the pipes. Low-weight bulk pipes and fittings can be unloaded manually. In case of heavy pipes and fittings, lifting devices and bands made of nonabrasive materials like manila rope should be used for up- and unloading. It is not allowed to use hooks on the pipe ends. If bulk pipes are unloaded from the back, an unloading mandrel should be used. Unloading from behind with a forklift is not allowed. It is not allowed to dump or throw them from the means of transport. Pipes grinding against the ground should be avoided.

### Storage

All pipes and fittings should be stacked on a flat support. Bends along the length should be avoided. Pipes packed in wooden crates (HRV) can be stacked on top of each other wood on wood up to 3.30 m.

Attention must be paid to avoid any sharp or pointy objects that could damage the bottom side of the pipes or the fittings. Unprotected storage for more than 12 months should be avoided. If the pipes are covered with opaque cover a good ventilation of the pipes and fittings must be ensured. Sealing elements have to be protected from light, in a dry and possibly cool place.

### Installation

### Pipe trench

The pipe trench is to be made according to DIN EN 1610. The trench floor shall be a soft material, free of stones. If this is not the case, a sand or fine-grained grit bedding has to be made (grain size = 0,8 x corrugation width). The thickness of the bedding has to be at least 2,5 times the corrugation height, so that the wave top of the profile does not lay on an inappropriate bedding.

### Laying

A manufacturer’s representative shall visit the site at the outset of pipe installation works to demonstrate proper installation procedures in accordance with manufacturer’s recommendations.

The Contractor shall report to the Engineer when excavations are ready to receive pipes or concrete foundations and shall not proceed with pipe laying, concreting or other works until they have been passed and approved by the Engineer. Any pipe laying, concreting or other work carried out without prior approval of the Engineer shall be removed immediately at the Contractor’s expense.

Pipes, fittings and sealing rings have to be checked for damages before they are lowered into the pipe trench, respectively before they are built in. The pipes are not to be thrown into the pipe trench. Damaged pipes, fittings and sealing material shall not be used.

The Engineer will check the pipes on the Site and the Contractor shall mark all defective or damaged pipes in accordance with the Engineer’s instructions and shall remove them from the Site immediately and replace them with acceptable pipes at his own expense. Only pipes marked as accepted by the Engineer after inspection on the Site shall be incorporated in the Works. The Engineer shall have the right to reject consignments or stocks of pipes from which failed pipes have been drawn, or order them to be pressure-tested outside the pipelines, even though no defects are apparent, if there is reason to believe that mishandling has taken place. All costs incurred in this respect shall be borne by the Contractor.

If partial lengths have to be made, a perpendicular cut shall be made through the middle of the corrugation ebb with a fine-toothed saw. The corrugation wave shall not be cut through. The cut surface shall be chamfered.

Pipes in gravity flow lines shall be laid consecutively in straight lines between adjacent inspection manholes within the following tolerances:

* the maximum permissible deviation in invert level in one section shall not exceed 2.0 cm or 1 mm per pipe section, whichever is less;
* the alignment and location in plan shall not deviate by more than 20 cm from the design line. The axial displacement of pipes entering any manhole and issuing from it shall not exceed 2 cm.

After being laid and jointed, the completed section between two manholes shall form one continuous tube, well supported over its entire length and with a straight and even invert according to the lines and grades shown on the Drawings. The straightness of each section between manholes shall be checked externally by means of a string stretched parallel to the designed invert line and supported at intervals not exceeding 7.5 m, and internally by means of a beam of light (either laser beam torch or sunlight reflected by a mirror).

The pipes are connected in the trench through two-way sliding sockets. Lubricants shall be used for this. Under no circumstances shall oils or greases be used (rubber sealing rings swell up and get corroded). Before the pipe is pushed into the two-way sliding socket, the appropriate sealing ring shall be placed in the appropriate corrugation. In case of DN 250-1200 pipes the sealing ring is placed in the first complete ebb, in case of pipes up to DN 200 in the second complete ebb.

The pipes are to be pushed in centred, in the direction of the pipe axis, and can be done manually, with levers or with a device and cant timber, so that the edge of the pipe is not damaged. The pipe shall be heaped up every 20-30 m to ensure a good positioning of the pipe. The trench can be filled up completely only after checking for possible displacements of the pipe, only during the cooler hours of the day.

Included in the manhole assembly shall be flexible watertight pipe-to-manhole connections (shaft lining with sand coating) as specified by the pipe manufacturer and as indicated on the drawings. Shaft linings shall be installed during the production of the precast concrete elements in the manufacturer’s factory.

Where property connection pipes are foreseen to be directly connected to the sewer pipe, branch pipes 90° with reduction shall be installed.

In order to equalize the expected differing subsidence between sewer manholes and sewer pipes, linking pieces (rocker pipes) with a length of up to 1.20 m shall be installed for every incoming and outgoing pipe. Linking pieces are connected to the shaft linings in the manhole on the one side and are connected to the sewer pipes with double push-fit sockets on the other side.

In order to prevent stones, soil or small animals from entering the pipe, a suitable cap end or plug (sealing cap) shall be provided with which the last pipe laid shall be sealed when pipe laying is not actually in progress.

### Filling up the trench

Compacting near the pipe shall be done in stages with light compacting devices. Attention should be paid that the material in the corrugations is compacted appropriately. The filling soil shall consist of material with grain size = 0,8 x corrugation width for up to 30 cm above the top of the pipe apex.

A correct and long-lasting laying is guaranteed, among others, by:

* Choosing the right filling material. The material must be dry and fine-grained. It cannot contain sharp edges, stones or debris around the pipe.
* Compacting is done in layers of 30 cm with an appropriate tool, until up to one meter over the pipe apex.
* The first layer of filling shall be over half the diameter of the pipe, in order to avoid the lifting of the pipe.
* The trench has to be compacted evenly around the pipe, to avoid displacements or abnormal bends of the pipe body.
* Until up to one meter over the pipe apex the compacting shall be done with light machines, above that with normal machines. Machines used for road construction shall be used only if it has been ascertained that it does not have a negative effect on the pipe below.

### Laying in groundwater

If the load over the pipelines laid in groundwater is not enough to keep them from raising up they shall be fixed in place through anchors or through additional load (e.g. concrete, sandbags, etc.). Due to the higher buckling pressure caused by groundwater it is recommended to perform a static calculation in this case.

### Leak tightness test

Leak tightness test is carried out according to DIN EN 1610 with air and/or water pressure with the testing pressure and duration set forth in this standard.

## Corrugated polypropylene Pipes

After responding to the main offer, the following alternative offer is allowed.



### Pipes and fittings

Corrugated polypropylene pipes and fittings shall be designed to DIN EN 16961, range 5 and prEN 13476 with the following class of rigidity and corresponding ring stiffness values (EN ISO 9969):

|  |  |
| --- | --- |
| Class of rigidity | Ring stiffness values |
| SN4 | minimum 4 kN/m2 |
| SN8 | minimum 8 kN/m2 |

Authorisation of corrugated polypropylene pipes and fittings shall be based on DIN 16961, DIN EN 12666 and DIN EN 13476. Pipes shall be suitable for all bedding materials and for all normal pressure tests as per DIN EN 1610 as well as for high pressure cleaning process as per CEN/TR 14920.

Pipes shall have been tested as per DIN 19537-2/DIN EN 681 to prove the water tightness and root resistance.

In accordance with DIN 8061, leaflet 1 13 the pipes, moulded parts and sealing elements shall be all resistant to chemicals between pH 2 (acidic) and pH 12 (alkaline) as well as to all sewage and ground substances as per DIN 1986.

Pipes and fittings shall be double wall; corrugated on the outside and smooth surface on the inside. Pipe couplings shall be with in-line belling joint or double push-fit socket with EPDM or oil-resistant NBR lip sealing rings. All connections on deformed pipes must be long-term watertight at an internal excess water pressure of min. 0.5 bar and must also display a short-term water tightness at an internal pressure of 2.5 bar.

The thickness of the internal wall shall be suitable for high pressure jet cleaning systems (180 bar). Minimum wall thickness shall be according to prEN 13476. Material properties of pipes and fittings shall correspond to the requirements of prEN 13476. Ring flexibility (capacity for deformation without rupture) shall be at least 30 % according to EN 1446. Abrasion resistance shall be certified according to EN 295-3. Delivery pipe lengths shall be 6 m.

### Transportation and storage

Refer to Item 8.2.2.

### Installation

Refer to Item 8.2.3.

### Leak tightness test

Refer to Item 8.2.4.

## Ductile iron pipes and fittings

After responding to the main offer, the following alternative offer is allowed.



### Ductile iron pipes

* Pipes shall be made of ductile iron with socket connection using standard joint gaskets made from Nitrile - NBR.
* Joint gaskets must be able to withstand attacks by chemical products and the risks associated with the presence of hydrocarbons and oils in particular.
* Inside they will be coating with Al-cement mortar pipe lining.
* Outside they will be zinc coating 200 g/m2 and,
* The finishing coat shall be red epoxy.

**Ductile Iron pipe shall comply with the following Standards:**

Specifications and test methods: EN 598 (ISO 7186)

Cement mortar pipe lining: EN 598 (ISO 4179)

Joint gaskets-material specifications: EN 681-1(ISO 4633)

### Ductile iron socket fittings

* Socket fitting should be made of ductile iron
* Connection shall be with push-in joint, with standard NBR gasket
* Joint NBR gaskets must be able to withstand attacks by chemical products and the risks associated with the presence of hydrocarbons and oils in particular.
* Inside and outside, fitting should be protected with red epoxy coating minimum 250microns.

Ductile Iron socket fittings shell be compliance with following Standards:

Specification and test methods: EN 598 (ISO 7186)

Standard gasket for connecting (material): EN 681-1(ISO 4633)

## GRP pips for sewerage and drainage



### General

For installation of centrifugal polyester sewer pipes applicable standards and norms are the following: BS EN 14364:2013, DIN EN1610 and other relevant standards, regulations related to safety at work. Pipe laying must be carried out in full compliance with the relevant standards.

### Transportation of pipes

In the factory, pipes are packed into cargo depending on the type of transport (rail, truck or ship). Pipes of different diameters can be transported inserted into each other, which may reduce transportation costs. Lifting of pipes can only be performed individually, using tape or similar devices for lifting (no hook). Moving of pipes is carried out by using a forklift or crane. On plane ground it can be done by usage of the appropriate roller pads. Pipes are delivered with pre-installed couplings.

### Storing of pipes

Pipes are to be stored on a flat surface (without concentrated loading) and must be protected from mechanical damage and pollution. If necessary, wooden supports are used.

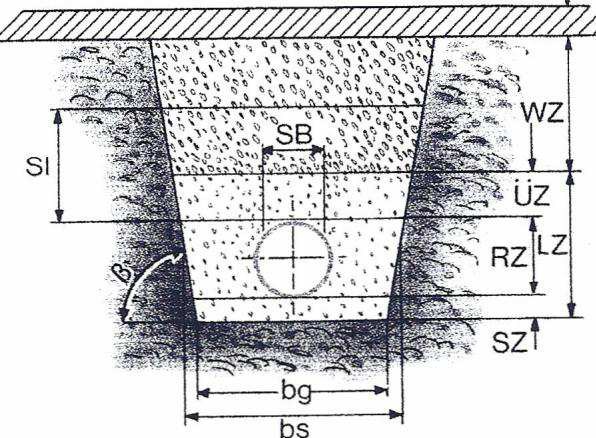
### Pipe laying

### Pipe trench

Minimum depth of the trench depends on the load acting on the pipe (traffic, soli, etc.). Also, it is very important to lay the pipe at a depth that is below freezing zone.

Excavated material that is not suitable for pipe installation should be removed. It is important to provide sufficient space in the pipe bedding for proper joining of pipes. After joining and testing of pipes, the trench is further backfilled with pipe bedding material, up to the prescribed level.

Figure 8‑1 – General cross-section of pipeline trench



* UZ - Upper zone
* WZ - Zone of backfilling
* SI - Safety zone
* RZ - Zone of pipe
* LZ - Zone of pipeline surround
* SZ - Bedding of pipe
* SB - Zone of pipe crown
* bg - Bottom width of the trench
* bs - Upper width of the trench (at the pipe crown elevation)

### Soil properties

Soil and pipe bedding must be of adequate bearing capacity. If soil is of inadequate bearing capacity, it must be replaced by imported pipe bedding.

Table 8‑1 – Soil categorisation in accordance with ATV standards

|  |  |  |
| --- | --- | --- |
| **Basic groups of soils** | **Soil types (according to ATV)** | **Deformation modulus EB for different degree of compaction DPR[%]**  **85 90 92 95 97 100** |
| **Group 1;**  **Granular soil, gravel** | GE: poorly graded gravel, granular soil,  GW: gravel with sand well graded  gravel  GI: medium graded mixture of gravel and sand  GU: mixture of sand and dust  GT: mixture of sand and clay | 2,5 6 9 16 23 40 |
| **Group 2;**  **Granular soil, sand** | SE: poorly graded sand, granular soil, SW: well graded mixture of sand and  gravel  SI: medium graded mixture of sand and gravel  SU: gravelly sand  ST: clayey sand | 1,2 3 4 8 11 20 |
| **Group 3;**  **Mixed soils** | GU: dusty gravel  GT: clayey gravel  SU: gravelly sand  ST: clayey sand | 0,8 2 3 5 8 14 |
| **Group 4;**  **Coherent soil** | UL: low plasticity dust  UM: mid-plasticity dust  TL: low plasticity clay  TA: high plasticity clay  OU: organic dust  OT: organic clay  OH: large or medium-grained soils | 0,6 1,5 2 4 6 10 |

### Bedding

Bottom of the trench must be planned and finished in accordance with the pipeline alignment and elevation. Any disturbance of the foundation soil compaction must be avoided. If, however, due to improper execution bottom of the trench is over-excavated, it should be levelled by a suitable material and uniformly compacted. It is necessary to anticipate locations for pipe joining in order to form pipe bedding properly.

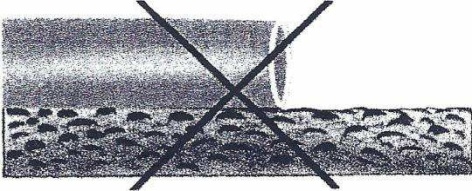
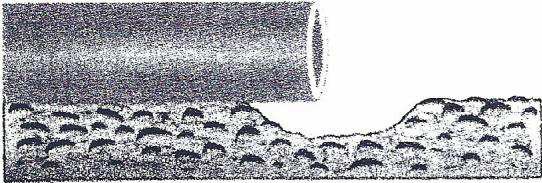
Bedding material shall meet the following minimal requirements:

* Material with grain size larger than 20mm must not be used.
* Bedding material should be granular, adequate for proper compaction and of sufficient bearing capacity
* At 95 compactness per Proctor minimal bearing capacity shall be 4 N/mm²

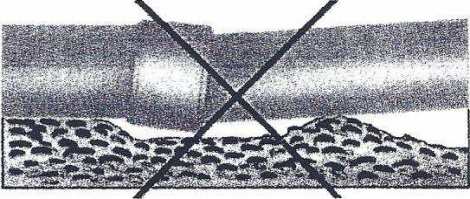
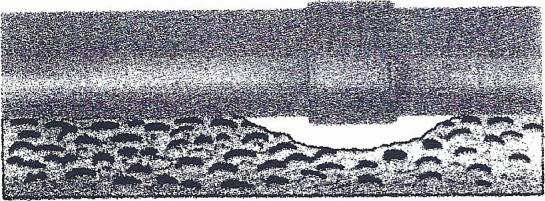
In water-bearing soils bedding material should not contain fine grains. For pipe diameters up to DN400 grain size should be 8-16mm, and for pipe diameters DN500 and larger grain size should be 16-20mm.

Minimal height of compacted pipe bedding under the pipe shall be 10cm, plus 0.1xDN. Pipes must fit closely to bedding along its entire length, except for pipe ends where pipes have to be joined.

**Figure 8‑2 – Pipe laying on bedding; correct and incorrect**



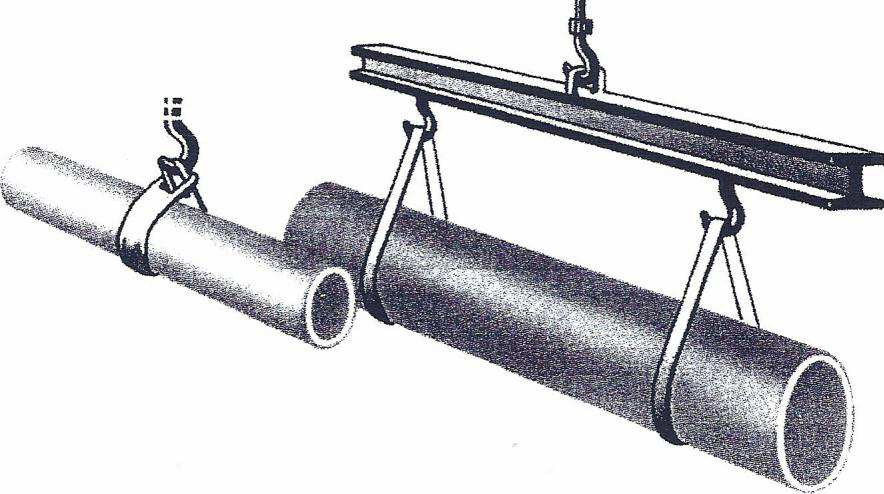
**Figure 8‑3 – Pipe laying on bedding; correct and incorrect**



### Placing of pipe in trench

Placing of pipe in the trench may be carried out manually (up to DN500). When using lifting equipment the use of bands is recommended. Pipe ends must not be damaged by using hooks.

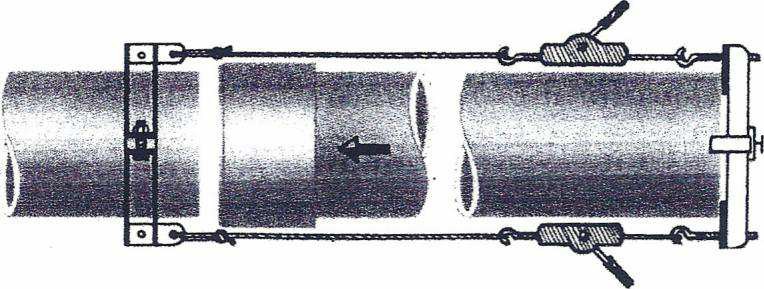
**Figure 8‑4 – Placing of pipe in the trench by cranes**



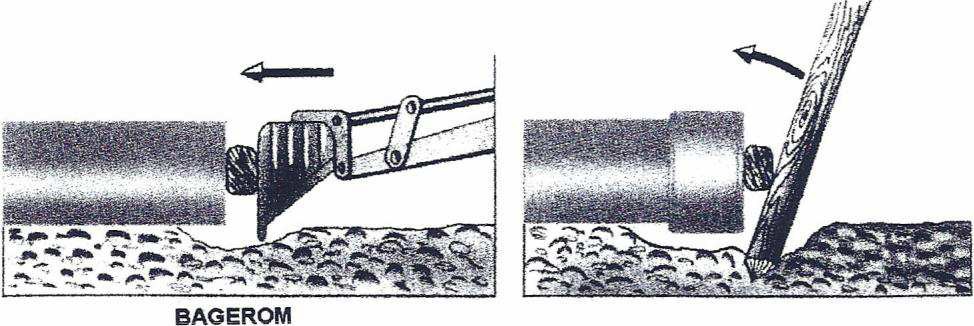
### Joining of pipes

Before installation pipes must be inspected and cleaned internally and externally. Couplings shall be thoroughly clean. Pipe ends and sealing gasket must be coated with lubricant which is delivered with pipes.

**Figure 8‑5 – Manual by pulling pipes**



**Figure 8‑6 – By using excavator**



### Allowable deflection angles

Depending on the pipes nominal diameter the coupling system allows limited deflection, as specified below:

* Up to DN500, inclusive - α max = 3°
* DN 600 to DN 900, inclusive - α max = 2°
* DN 1000 to DN1400, inclusive - α max = 1°
* > DN 1400 - α max = 0.5°

Neighbouring pipes are joined without any deflection, straight, and then rotated up to the maximum allowable deflection angle for particular DN. For construction of the sewerage system any deflection angles between two neighbouring inspection manholes should be avoided.

### Pipe laying in bedding material

Pipe bedding material shall be placed and compacted up to the elevation of 30cm above the pipe crown. During placing and compaction which is performed simultaneously on both sides of the pipe maximal layer of bedding material placed at a time shall not exceed 30cm.

Only light vibrating equipment (up to 0.30kN) or vibrating plates (up to 0.10kN) are allowed for compaction of bedding material. Compaction should be in accordance with the ONORM B2538-part 2, or equivalent. Maximal grain size of bedding materials for pipes DN200 to DN600 must not exceed 20mm. Bedding material must be granular, suitable for compaction, and at compaction rate of 92 (per Proctor) minimal bearing capacity of material must be ≥ 3N/mm2.

### Trench backfilling

Trench backfilling (with selected excavated or imported granular material) shall be carried out in layers of up to 0.30m. For backfilling of the trench at depths between 0.30 and 1.00m above the pipe crown, compaction should be carried out by a mid-weight vibrating equipment (maximal weight up to 0.6kN) or vibrating plate (of maximum weight up to 5kN). Heavier compaction equipment could be used for trench backfilling and compaction at depths above 1m of the pipe crown. During construction works heavy mechanisation and trucks should not cross directly over the trench with installed pipes.

Removal of trench formwork and supports should be done simultaneously with additional backfilling and compaction, i.e. the trench should be completely filled with properly compacted backfilling material.

### Pipe cutting

Polyester pipes can be shortened to required measure directly on site by using adequate cutting saw. After cutting edges are finished and coated with lubricant, the coupling can be directly installed, without additional processing.

## Connection to existing sewers

To connect to existing sewers the Contractor shall provide the required fittings and pipe adapters.

For the transition of the different pipe materials pipe adapters as specified by the manufacturer for the selected pipe material or double sliding flexible sockets shall be used. Double sliding flexible sockets shall be U-Flex, GGG 50 with exchangeable sealing and press rings, PN 1, incl. bolts and nuts DIN 601 from hot-dip galvanized steel, quality 4.6 with flat gaskets with metal inserts.

## Filling and sealing of abandoned pipelines and storm sewage overflows

Buried pipelines to be abandoned shall be sealed with sulphate resistant non-reinforced concrete C 20/25. Plug length shall be minimum 1000 mm.

## Concrete Bedding, Protective Slab, and Surround

In exceptional cases, where shown on the approved Contractor’s Drawings or determined by the Engineer, pipes shall be bedded on or in concrete. Concrete bedding shall be placed to the dimensions and in accordance with the construction details shown on these Drawings.

Concrete used for bedding of pipes (if any) shall be plain concrete of grade C15. Concrete used for slab protection shall be reinforced concrete of grade C20. Pipes which shall be effectively anchored to prevent flotation shall be laid into concrete. Before casting the concrete each pipe shall be supported and jointed at the correct level, clear of the trench bottom upon two pre-cast concrete blocks of suitable height, each supporting one end of the pipe. The pre-cast blocks shall first be properly set on the trench bottom and boned to the correct position and level. The pipes shall then be laid on the blocks and properly centred, socketed and finally brought to the correct gradient by the application of wooden wedges one on each side of the pipe and between the pipe and the concrete blocks. Concrete shall then be poured and rammed beneath and around the pipes in one operation and finished off to the levels and dimensions shown on the Drawings. The wedges shall remain in position whilst the pipes are jointed and tested, as herein specified and during the pouring of the concrete beneath and around the pipes. The Contractor may, according to his own choice, pour concrete either with or without forms. Whatever the Contractor chooses, the concrete for payment shall be measured as per the Drawings and no extras shall be paid for dimensions in excess of those required according to the Drawings. In no case shall the Contractor pour concrete at pipe fittings. Pipe fittings shall be kept free of any concrete to a distance of 10 cm on either side of the fittings and surrounded by bedding material as specified above.

## Crossing Watercourses

Where the pipelines cross streams, ditches, culverts and other watercourses the Contractor shall allow for all the additional measures necessary for the proper construction of the Works at these crossings including maintaining the full flow of water.

Pipelines crossing watercourses shall be constructed as shown on the standard detail drawings.

## Testing of pipelines



### General

Sewer pipelines shall be tested on site as follows:

* test of horizontal and vertical alignment
* test for water tightness
* test of deflection

After the laying and jointing of a section of sewer line (defined as the length of sewer line between two adjoining manholes) has been completed, that section shall be inspected and tested in accordance with DIN EN 1610.

Should the pipeline fail to meet the Specifications, the Contractor shall do whatever is required to remedy any defects or leaks that have been established. The Engineer may in certain cases require the excavation of the sections concerned.

Testing will be repeated as soon as the repair works have been satisfactorily completed. Pipelines shall be tested in lengths between manholes or such shorter lengths as the Engineer may direct or permit.

Pipelines shall be tested in the presence of the Engineer.

Fitting required for temporarily closing the opening in pipelines to be tested shall be properly designed for this purpose and shall be adequately strutted for the test pressure specified.

The arrangements for testing a pipeline shall include provision for the purging of air from the sewer line prior to a water test. The Contractor shall keep a record of all tests in a book, which shall be available for inspection. A copy of each page shall be handed over to the Engineer. A space shall be provided on each page for the Engineer’s representative to sign when he has witnessed the testing recorded thereon.

Before testing any sewer line, the Contractor shall ensure that it is anchored adequately and that thrusts from bends, branch outlets or from the sewer line ends are transmitted to solid ground or to a suitable temporary anchorage. Open ends shall be stopped with plugs, caps or blank flanges properly jointed.

Gravity sewers shall be tested by the Contractor after they are jointed and before concreting or backfilling is commenced, other than such as may be necessary for structural stability whilst under test.

The levels, alignments, gradients and dimensions of the sewers shall be examined accordingly to the design.

The joints shall remain exposed, joint grooves shall not be filled until all inspections and tests have been completed to the satisfaction of the Engineer and until he has given permission in writing to proceed with the covering-up of the sewer line.

The following inspections and tests shall be carried out:

* visual inspection, in which the Engineer shall inspect the section for grade, direction, line, appearance of inner surface, depth and correct jointing;
* leakage test (appropriate water or low pressure air testing) - for gravity pipes;
* Hydraulic pressure test - for force mains.

Costs of all these works shall be assumed to be included in the rates and prices of the BoQ and no extra payment shall be done to the Contractor.

### Execution and Workmanship

The section to be tested shall be tightly closed or plugged and the vent systems completed. The Contractor shall provide all labour, pumps, manometers and auxiliaries during the test periods. The personnel shall be of a class and qualification as specified by the Engineer. Each pump to be used by the Contractor shall be provided with a recording water gauge, a recording manometer, including a facility for an extra connection for a control-manometer and dead weight tester. Pumps and manometers shall be of a make and type suitable for the work to be executed, in a good state of repair and well adjusted. The pumps and/or manometers shall be subject to the Engineer’s approval. All tests shall be conducted in the presence of the Engineer. If any leak in joints or evidence of defective pipe is disclosed, the work shall be immediately detected and corrected or replaced to the Engineer’s satisfaction. No makeshift repairs or application of patching compounds shall be permitted. After the correction is made, supplementary tests shall be run until a satisfactory working condition is obtained.

### Leakage Test

The leakage tightness of every completed section between two manholes shall be tested according to DIN EN 1610, Worksheet ATV-DVWK-A 139 and the Advisory Leaflet ATV - M 143-6E.

The relevant sewer section, especially the contact area between pipe plugs and pipe surface, shall be clean to ensure a tight fit of the plugging elements and to guarantee an undisturbed conduct of the leakage test. Prior to the leakage test, the tightness of the testing equipment shall be tested and recorded. The leakage test shall be carried out individually for each manhole-to-manhole section.

The leakage test can be executed by using air or water. As the air pressure testing can be completed significantly faster, this should be considered the preferable test method. In case the Engineer considers the result of an air pressure not reliable, the Contractor shall carry out a low water pressure test from which the result shall be deemed as prevailing.

The result of the leakage test shall be accurately and comprehensively documented in a test protocol. The documentation shall comprise:

* Information of the tested section;
* Test requirements;
* Measuring values and charts;
* Test certificate.

The test protocol shall include the following information:

* Employer, Contractor, project manager, equipment operator, place, date, time, street, number, section number and/or numbers of adjoining manholes;
* Characteristics of the to be tested section, e.g. type of test (testing in sections, socket joint testing), nominal diameter, length of section, pipe material, type of sewer, year of construction, ground water level;
* Information on applied test standards, test pressure, testing time and duration, permissible air pressure difference respectively permissible added water quantity;
* Measuring result: measured air pressure difference respectively measured added water quantity;
* Chart of the air pressure test: chart of the pressure variation during the test duration including the required test pressure, permissible pressure difference, beginning and end of required standstill period as well as begin and end of the test period;
* Test certificate with the result of the leakage test signed by the attending participants.

Test protocols shall be assigned with a consecutive number and shall be systematically filed.

### Low air pressure testing

The Contractor shall provide the following test equipment for the air pressure test:

* Plugging elements,
* Compressor or compactor,
* Filling equipment including pressure reducing valve respectively electronic pressure shut-off, pressure measuring device,
* Device for the recording and storage of the measuring data.

As the air pressure test according to accident prevention guidelines is rated as dangerous work, the following minimum requirements shall be met:

* The air pressure test shall not be carried out by a one person only.
* The test shall be executed by authorized experts that are familiar with the associated potential hazards.
* A supervising expert shall be present.

The pressurization of the section to be tested as well as the control and venting of the test pressure shall be carried out safely from the ground surface. Surpassing of the test pressure must be excluded by ensuring that the test pressure is:

* Monitored by means of a manometer (pressure gauge);
* Limited to the prescribed value by a perforce operating safety valve respectively by an electronic pressure shut-off.

Beginning with the pressurization all works on the pipe and in the adjoining manholes shall cease. During the duration of the test nobody shall be present in front of the plugging elements and in their danger zone.

The air pressure test is considered successful when the following test criteria are met:

Test pressure: P = 100 mbar

Permissible pressure difference: p = 15 mbar

Required test duration: according to table below

Standstill time: tB = 10 × di in [min], diameter di in [m].

Required test duration

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Nominal diameter DN | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
| Required test duration [min] | 3 | 3 | 4 | 5 | 7 | 8 | 10 | 11 | 13 | 14 |

### Low water pressure testing

The section shall be cleaned so that the joints may be observed from the outside. The two ends of the section shall be hermetically sealed by suitable temporary plugs provided with pipe nipples. The upstream plug shall be connected to a standpipe extending at least 0.50 m above the top of the highest pipe. Water shall then be introduced through the opening in the lower pipe end to fill the pipe and expel the air through the standpipe, until the water level in the standpipe is 0.50 m above the top of the lowest standpipe. Alternatively, a sewer section maybe tested together with the upstream manhole.

The pipeline should be filled with water 1 hour before performing the actual test for 30 minutes. All visible leaks in the joints shall be repaired.

The quantity of water that must be added to maintain the water level in the standpipe shall be measured and this will be considered as the leakage of the tested section.

The pipe passes the test if the water volume to be added during this time is no greater than:

- 0.15 l/m2 for pipelines and sewers

- 0.20 l/m2 for pipelines and sewers with manholes

If the leakage during the test period exceeds the permissible rate, the Contractor shall search for and make good all defects causing such leakage. The test and repairs shall be repeated as often as necessary until all visible leaks have been repaired and the leakage does not exceed the permitted limit.

All necessary testing apparatus, expanding plugs, stoppers, bladders etc., labour, water and any other materials necessary for testing shall be provided by the Contractor at his own expense.

### Hydraulic pressure test

This test shall be applied to all force main pipes.

Written notice shall be delivered to the Engineer, a minimum of one week prior to the date required for any pressure testing of pipelines.

After visual inspection has been completed and accepted, the Contractor shall pressure test each section. He shall ensure that all pipes are secured before testing commences and provide any temporary support, which may be necessary.

The water test pressure for gravity sewers shall be carried out for pipeline sections between two consecutive manholes; the sections’ lengths will not exceed 250 m.

The water pressure shall be 5 m head of water above the pipe soffit or ground water level at the lowest point of the section. Steeply graded sewers shall be tested in stages in cases where the maximum head, as stated above, would be exceed if the whole section were tested in one length.

The pipeline shall be filled with water and a minimum period of 24 hours for concrete sewers and 1 hour for the others shall be allowed for absorption, after which water shall be added from a measuring vessel at intervals of 5 minutes and the quantity required to maintain the original water level noted.

The Contractor shall provide all test rigs, temporary blind flanges, gauges, pressure raising equipment, pressure recording instruments and all other necessary equipment to satisfactorily carry out the tests as described in the Specifications.

All gauges and equipment are to be submitted for approval to the Engineer. A circular pressure recorder shall be installed to provide a continuous record of the test and the chart submitted as part of the documentation for each pressure test performed.

The Contractor shall supply all labour and supervision needed for the performance of the tests and recording the results.

Before starting these tests, any valves included in the test assembly shall be checked for proper mechanical working order and then set in the open position. No testing shall be carried out against closed valves except where permission is granted by the Engineer. Blind flanges shall be inserted or installed as required.

Pipe joints, valves and fittings shall also be checked over carefully for loose bolts or connections which might cause leakage and delay the execution of the tests.

Should any section fail to pass the tests, the Contractor shall determine the cause of the failure and shall locate, excavate and repair any damage or leakage sustained by the pipeline before or during the tests and retest the section. The cost of such repair work, including (but not limited to) additional excavation and backfilling; repair or replacement of pipes; and the abortive test shall be borne by the Contractor.

After filling with water, the desired pressure to the pipeline shall be applied by a small capacity high pressure positive displacement pump drawing from a suction tank where the volume change can easily be checked and measured.

The section under test shall be properly sealed off, with special stop end caps held securely in position by adequate temporary anchorage. All peak points of the pipeline shall be adequately vented during the filling operation to expel as much air as possible.

The Contractor shall be responsible for supplying water from a source to be identified by him with the Engineer’s approval.

Unless otherwise specified, the length of pipeline shall be accepted if the quantity of water added over a minimum 15 minute period is less than 0.2 litres per square metre of wetted surface.

Notwithstanding the satisfactory completion of the above test, if there is any discernible leakage of water from any pipe or joint, the Contractor at his own expense shall replace the pipe and/or remake the joint as appropriate, and repeat the test.

The sewerage shall be also tested by means of an inspection video camera.

If the calculated leakage rate is within the allowable leakage rate, the test water shall be transferred to the next section of the pipeline to be tested or disposed of as approved by the Engineer.

On completion of testing, the section of pipeline shall be properly sealed to prevent the intrusion of any extraneous matter until connected to the pipeline network.

### Deflection Test

The deflection of flexible pipes shall be tested for conformity with the static calculation. The change of diameter should not exceed the figures for short-term and long-term deformation as shown in the static calculation (refer to ATV-DVWK-A 127). The permissible short-term and long-term values take into account the actual installation conditions and long-term deformations according to ATV-DVWK-A 127.

The change of diameter shall be optically or mechanically tested. The criterion for acceptance is the permissible value for the short-term deformation that was determined in the static calculation.

Prior to the testing the section of pipe to be examined shall be cleaned. During the test the horizontal and vertical diameter shall be measured. The maximum deviations from the original condition of the pipe prior to the installation shall be shown in a diagram in the test protocol.

## Cleaning of sewer lines

During installation the Contractor shall keep the interior of pipes clean and free from water, dirt, stones, rubbish and other foreign matter. Upon completion of laying and jointing the interior of the pipes shall be thoroughly flushed to remove remaining traces of foreign matter and thereafter maintained in such condition until taken over by the Employer. The unit prices include the delivery of the detergent and disposal of the deposits.

## CCTV

Before taking into operation, the Contractor may be requested to carry out an inspection of the sewers by using a camera (CCTV). The inspection normally follows immediately the cleaning operation.

The results of the inspection shall contain the following:

* A written report of the inspection containing factual information about the sewers. Also it shall include coded condition information.
* Coded inspection data in electronic format for direct entry into a database.
* All visual inspection data shall be recorded and coded in accordance with the coding system in accordance with EN13508-2.
* A video recording of the inspection on electronic format (DVD).

The following data must be included in the recordings on a DVD:

* Pipe diameter,
* Pipe materials,
* Length of the sewer,
* Slope of the sewer,
* Location and type of the sewer,
* Longitudinal profile of the sewer
* Number of the manholes and chainage,
* Location of sewer service connections,
* Certificate of the specialized company,
* Date and time of the inspection
* Survey of the branches and the damages, and so on.

The submittal of the DVD and of the written evaluation report should be included in the unit price.

The recording and assessment of the conditions of the sewer systems shall be carried out by CCTV (closed circuit television) system, provided by the Contractor. The CCTV system shall be capable of 360 degree pan, tilt and zoom. The camera system shall have incorporated an inclinometer so that variations in gradient can be measured and also it must be able to operate at low light levels.

In pipes of DN 500 mm and above, all the joints shall be inspected over 360°.

## Control manholes



### General requirements

For control and cleaning of the new sewers the Contractor shall install control manholes. Manholes shall be constructed to the dimensions and at all locations where the pipe changes directions and at inlets of other collectors as indicated in the Drawings.

The delivery of all parts should be initiated only after control of the local site conditions.

If the inner drop between the connected pipe bottoms is smaller than the largest connected pipe diameter, then the channel bottom shall be shaped to provide for a gradual transition between the connected pipe bottoms without any drops.

Where the drop between the connected pipes is larger than 1.00 m, manholes shall be furnished and installed with an external drop according to the ATV and other relevant regulations.

The manhole diameter DNS depending on the diameter of the connecting pipe DN shall be as shown in the following table:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DN | 200 | 250 | 300 | 350 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1200 | 1400 |
| DNS | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1200 | 1200 | 1400 | 1400 | 1600 | 1800 |

The manhole base shall be designed to provide stability against buoyancy.

The invert of manholes shall be formed in such a fashion that they are smooth and will not obstruct flow of sewage. The top of the flow channels in the manhole base shall be equal to the top of the pipe. The manhole landing shall be sloped from the wall line to edge of flow channel in a grade of 1:20 with a liberal radius applied at flow channel intercepts.

### Precast Reinforced Concrete Manholes

As sub-base for the precast concrete manholes the Contractor shall place a 10 cm thick layer of non-reinforced concrete with strength of 15 N/mm2.

The circular precast reinforced concrete manholes shall comply with DIN 4034. The precast concrete elements shall have the quality-control label of a certified concrete factory.

Concrete shall have a high sulphate resistance and a low effective alkalinity according to DIN 4034. Unless otherwise approved, blastfurnace cement CEM III/B DIN 1164 shall be used throughout according to National Standards and shall have maximum concentration of C3A (Tricalciumaluminat) 3%. Cements with low hydration heat shall be used.

With regard to the expected loads the concrete should be impermeable to water (Penetration depth: ≤ 5 cm), resistant against “high” chemical corrosion according to DIN 4030 and proof a high frost resistance.

Concrete strength class shall be C35/45.

Reinforcement shall be according to DIN 488 and be designed to resist handling stresses incurred before and during installation.

The manhole shall be complete with:

* Precast base,
* Base section,
* Riser sections (in different heights from 0.25 to 1.00 m),
* Grade rings for precise adjustment of top elevation (in different heights from 60 to 100 mm),
* Cone section 600/1000 mm,
* Concrete cover plate.

Included in the manhole assembly shall be flexible watertight pipe-to-manhole connections as specified by the pipe manufacturer and as indicated on the drawings.

Flexible watertight pipe-to-manhole connections shall be:

* Shaft lining with sand coating
* Pipe inlet in sand-coated protective pipe with seal

Shaft lining and protective pipes shall be installed during the production of the precast concrete elements in the manufacturer’s factory.

A subsequent on-site manufacturing of wall openings for pipe connections is not acceptable.

Joints shall be single offset with socket joint sealing with elastomer sealing ring DIN 4060, Part 1.

Channel lining of the precast manhole base shall be vitrified clay half pipes or sewer bricks. Platforms shall be lined with sewer bricks or clinker quarter bricks.

### Cast-in-place manholes

This section refers to the overflow manhole. Sewer manholes shall be made of precast reinforced concrete elements.

### Concrete quality

DIN1045 shall govern for all concrete works.

As sub-base for the reinforced concrete floor slab of the manhole the Contractor shall place a layer of non-reinforced concrete, at least 10 cm thick, with strength of 15 N/mm2 (C12/15).

Concrete strength class C30/37 shall be used for the cast-in-place reinforced concrete manholes.

Nonreinforced concrete with strength of 25 N/mm2 shall be used for the flow channels.

Concrete mixes have to be in accordance with the following table:

|  |  |
| --- | --- |
| Characteristic compressive  strength (N/mm2) (28 days)  Maximum water/cement ratio  Minimum cement con­tent (kg­/m3)  Maximum size of aggre­gate (mm) | 35  0.55  350  32 |

Unless otherwise approved, blastfurnace cement CEM III/B DIN 1164 shall be used throughout, according to National Standards and shall have maximum concentration of C3A (Tricalciumaluminat) 3%.

With regard to the expected loads the concrete should be impermeable to water (Penetration depth: ≤ 5 cm), resistant against “weak” chemical corrosion according to DIN 4030 and proof a high frost resistance.

The temperature of the freshly mixed concrete shall not fall below +5 C and not exceed + 30 C.

The quality control and the analysis of the required wet and hardened concrete parameter shall be carried out in accordance to DIN 1045. Tests shall be done in accordance to DIN 1048 Part 1 and 5.

### Testing of Concrete

##### ***Sampling***

The Contractor shall be obliged to take samples of concrete and make concrete cubes for testing purposes in accordance with the requirements outlined below.

Cubes for concrete sampling shall be 150 mm x 150 mm x 150 mm. The number of cubes to be taken for testing shall be as follows:

1. 1-3 cubes per load of concrete for loads of 4-6 m3;

2. 1-2 cubes for every 4 batches if each batch is of the order of 0.5 m3;

3. 1-2 cubes for every 10 batches, if every batch is less than 0.5 m3.

The Engineer may at his discretion vary the frequency of concrete sampling, depending on the results of testing.

One cube shall be made from a sample taken from a randomly selected batch of concrete. Samples shall be taken at the point of discharge from the delivery testing obtained. All concrete cubes taken shall be numbered for recording purposes.

The number of cubes made may be reduced by the Engineer if consistently satisfactory results are obtained or increased if, in the opinion of the Engineer, additional tests are required as, for example, in the early stages of the Works. The Contractor shall be obliged to make, cure, store, transport, and test in compression concrete cubes in accordance with BS 1881. The tests shall be carried out in a laboratory approved by the Engineer and reports of all tests made shall be supplied to the Engineer within 24 hours of the cubes being tested. A record of such tests, identifying the test cubes with the part of the work executed, shall be kept by the Contractor on Site and made available to the Engineer on request.

### Reinforcement

Reinforcement steel shall be ribbed (in horizontal and vertical direction) with yield strength of 500 N/mm2 according to DIN 488. The concrete coverage of the reinforcement should be 4.0 cm. To fix the reinforcement in the forms during pouring of the concrete and ensuring the required coverage the Contractor shall use spacers.

### Formwork

Formwork shall be sufficiently rigid and tight to pre­vent loss of mortar from the concrete-mix and to maintain the correct position, shape and dimensions of the fin­ished work. Formwork shall be constructed so as to be removable from the cast concrete with­out shock or dam­age.

### Foundation Earth

For the main equipotential bonding galvanized band steel with a cross-section of 30x3.5 mm shall be installed on the lower reinforcing layer of the reinforced concrete floor slab as foundation earth, including all appurtenances, spacers, binding wire connections to the reinforcement and connection lugs. The galvanized band steel shall form a closed ring. Concrete covering of the band steel should be at least 5 cm.

The two connection lugs shall be made of galvanized band steel with a cross-section of 30x3.5 mm according to DIN 18014 and 18015. The Contractor shall provide for the complete corrosion protection of the connection lugs.

### Construction Joints

Before pouring concrete is resumed at a joint, roughened surfaces shall be washed clean of all loose material and will be free of the surface sweat, mould oil and grease. These surfaces shall be thoroughly wetted, preferably by soaking overnight, care being taken to avoid free water on horizontal surfaces immediately before concreting.

An expandable rubber joint tape shall be located at all construction joints to prevent entering of groundwater.

### Polypropylene manholes

Manhole DN 1000 shall be made of polypropylene, for installing without machinery, 100 % new material with no recycled content, consisting of solid walled finished parts with reinforcing-rings, ring stiffness >= 2 kN/m², manhole base with an inlet with firmly inserted sealing rings (safety lock), outlet as spigot end, in accordance with DIN EN 476, DIN EN 752 and in line with DIN 19537, approved and certified from construction institutes.

The manhole assembly shall have a partially eccentric cone and shaft rings; cone with horizontal and vertical profile ribs for best possible load dissipation. Load capacity up to SLW 60, buoyancy-proof by virtue of horizontal reinforcement ribs. PP shaft rings DN 1000 shall be water tight connected using sealing rings DN 1000

Manhole base DN 1000 shall be with flat base, distortion-proof, smooth, complete, pre-assembled fixed EPDM sealing ring), berm surface textured and non-slip, channel height up to apex in accordance with ATV-DVWK\_A 157, inlet and outlet as socket. Shaft element connection achieved by multiple lip seal to DIN 4060 and EN 681-1.

A concrete bearing ring for covers DN 625 to DIN 19584 EN 124 shall be installed for firmly holding standard cover LW 600.

The cast iron/concrete cover DN 625 shall be Class D 400, ventilated to DIN 19584, EN 124. Moving loads are carried away directly into the road’s substructure by means of a load distributing plate.

Manhole assembly shall include step ladder or corrosion-resistant, silver-grey steps made of glass reinforced plastic, in accordance with the requirements of the trade association

Shaft connections and side inlets shall be as indicated in the Drawings. PP side inlet shall be with double connecting sleeve and pre-assembled fixed EPDM sealing ring (safety lock), with minimum 15mm height offset from main pipe.

Installation depth shall be in accordance with the Drawings.

### Glass fibre-reinforced polyester resin (GRP) manholes

As sub-base for the precast concrete manholes the Contractor shall place a 10 cm thick layer of non-reinforced concrete with strength of 15 N/mm2.

Manhole DN 1000 shall be made of lightweight glass fibre-reinforced polyester resin (GRP), leak proof, certified to 175 kN, approved and certified from construction institutes.

The manhole shall be complete with:

* Precast base,
* Base section,
* Riser sections (in different heights from 0.25 to 1.00 m),
* Grade rings for precise adjustment of top elevation (in different heights from 60 to 100 mm),
* Cone section 600/1000 mm,

Shaft element connection achieved by multiple lip seal to DIN 4060 and EN 681-1.

A concrete bearing ring for covers DN 625 to DIN 19584 EN 124 shall be installed for firmly holding standard cover LW 600.

The cast iron/concrete cover DN 625 shall be Class D 400, ventilated to DIN 19584, EN 124. Moving loads are carried away directly into the road’s substructure by means of a load distributing plate.

Manhole assembly shall include step ladder or corrosion-resistant, silver-grey steps made of glass reinforced plastic, in accordance with the requirements of the trade association

Pipe connections shall be watertight and as indicated in the Drawings.

Installation depth shall be in accordance with the Drawings.

### Manhole Accessories

### Access Covers and Frames

Manhole cover and frame for sewer control manholes shall be ductile iron ISO 1083 and comply with EN 124. All covers shall be Class D400 for heavy traffic, circular, with hinge - maximum opening to 130º, safety blocking at 90º, ventilated type, with sealed handling box, with anti-theft cover lock, with lifting rings integral with the frame. The covers shall be lockable. All manhole covers supplied under this Contract shall be embossed with an inscription as confirmed by the Engineer in advance of the Contractor placing his order for covers.

Dimensions:

Clear opening: 610 mm

Frame depth: 100 mm, with anchoring slots

Frame/cover seating: Elastomer ring

The manhole covers shall be installed in a manner to to prevent surface water run off from entering.

Each manhole cover shall be equipped with a galvanized steel mudpan according to DIN 1221 Form F with cross rod and four suspension legs resting on the elastomer ring. Compatible to the manhole cover, the mudpan should not impair the proper functioning of the cover.

### Step Irons

Step irons shall be non corrosive cast iron according to DIN EN 13101, DIN V 1264 and DIN 19555, single flight.

Step irons shall be designed to provide sound stability, shall have an anti slip design on the top face, a safe grip and raised sides to help prevent foot slippage.

Dimensions:

* minimum width of foothold 300 mm
* minimum depth of foothold of 150 mm

Step irons shall be bolt-on or built-in type. Holes for the anchorage in the wall shall be drilled and filled with cement grout after installation of the step irons.

All fixing appurtenances (bolts, dowels, screws, washers, etc.) shall be stainless steel (Material-No. 1.4571).

First step shall be placed 30 cm below the manhole cover. Maximum vertical distance between step irons shall be 25 cm.

### Testing of Manholes

The Contractor shall provide all water, labour, pipes, stoppers, bends and other necessary equipment for carrying out tests, and no manhole or other work must be covered up, until they have been checked and approved by the Engineer.

The test to be applied on manholes shall be their filling with water to at least 50 cm above the top of the highest pipe.

To demonstrate water tightness a leakage test shall be carried out according to DIN EN 1610. The manhole should be filled with water 1 hour before performing the actual test for 30 min. The manhole passes the test if the water volume to be added during this time is no greater than 0.40 l/m2. If this requirement is not complied with, the Contractor at his own expenses shall repair the manhole and repeat the test. The Contractor has to deliver and dispose of the test medium.

Costs of all these works shall be assumed to be included in the rates and prices of the BoQ and no extra payment shall be done to the Contractor.

## Service connections



### General

In the Employers’ design the property connections are indicated indicatively only. The exact locations of house connections shall be established on site by the Contractor and shall be approved by the Engineer. The structural details of each property connection shall be agreed upon by the Contractor and by the Engineer prior to the delivery of the materials. At least one house connection shall be provided to each property adjacent to a sewer line. The Contractor is responsible for showing the exact locations of these house connections on As-Built Drawings (including the exact distance parallel and perpendicular) to the nearest upstream manhole.

House connections shall have a maximum depth to invert of 1.50 metres at the property line depending on the installation depth of the yard piping. They shall have a minimum slope of 2%.

Properties shall be connected directly to sewer pipes only. A direct connection to the control manholes of the sewer network is not acceptable.

In order to minimize the number of pipe connections to sewer mains, the Contractor is encouraged to construct local collectors serving up to four properties where applicable. The local collectors would merge into a PE/PP inspection chamber DN 400 placed in the footpath in front of the connected properties.

In case of direct connection to the sewer, house connections shall be made using branch pieces 90° with reduction.

All changes in direction shall be made with suitable fittings (bends). Fittings shall be of the push-on type with suitable rubber gaskets for the type of piping used. No glued connections shall be permitted.

The house connection shall extend 1.0 metre inside of the property being connected.

For sewer pipes up to a diameter of DN 800 the connecting point to the collector shall be between springing line and top of pipe.

At all times when pipe laying is not in progress or the trench is left unattended, the open ends of the pipe shall be closed temporarily with end caps. Caps shall be capable of remaining in place against a hydrostatic pressure equal to that used to test the main sewer pipe.

Property connections to be constructed under this contract shall be connected to the existing wastewater service pipe in the yard of the consumer by using the specified pipe adapters for the transition between different diameters and materials.

For properties without buildings foreseen for future connection to the sewer network the end of the house connection at the property will be closed with an end cap. The Contractor will mark the location of the capped ends with a 5 x 5 cm wooden post, 1.00 m long with its top flush with the existing ground level, and painted.

### Lateral Connecting System

After responding to the main offer, the following alternative offer is allowed.

Pressurised and safe lateral connection system to sewer pipes with a structured-wall outside and a smooth inner surface according to DIN EN 13476:

The lateral connecting system consists of:

* Flexible Connection seal made of SBR including a end lip placed on the inner surface;
* Screwing crown made of PP, arranged as pipe fairlead;
* lubricant and assembly instructions.

The lateral connecting system shall be applicable fort the connection of service connection pipes ID 150/OD160 to sewer pipes from OD 315 to ID 800 and provide durable tightness up to 0.5 bar.

The lateral connecting system shall have a double sealing function (connection seal is pressed against the inner cut surface of the core-hole drilling, compression of lip-seal against the inner surface, which arise by reason of screwing the screwing crown into the connection seal).

During assembly the Contractor shall follow the manufacturer’s instructions and use the manufacturer’s installation tools.

Installation

1. Step:

The connection point must be free excavated and cleaned. A borehole with an appropriate diameter (page 3) must be placed by using a drill machine at the connection point. The drilling has to be perpendicular to the pipe axis (approach drill machine the drilling stand on wave crest), ovality is only within the bore tolerances acceptable. The dimensions are measured and controlled at the inner surface of the inliner. The bore hole boarder must be deflashing.

2. Step:

Ensure connecting seal is free of dirt. Insert connecting seal without lubricant into the bore hole. It must be regarded that the inner end lip lies against the inner surface according to Image 7 and 8. If necessary pull inner the end lip against the inner surface of the pipe. The arrows of outer seal have to point lengthwise of pipe.

3. Step:

Apply external screw thread of the screwing crown with lubricant. Afterwards screwing crown is plugged in slightly. The first screws are made by hand until the screwing crown is firmly attached into the seal. Thereafter the screwing crown is screwed equally and centrically into the connection seal until the last pitch with the aid of the installation tool. The connection seal must be screwed (max.1/2 revolution) as far as vertical marking is placed above the arrows of seal. It must be regarded that the end lip does not detach from pipe’s inner surface.

4. Step:

Apply lubricant onto spigot end of pipe which should be connected and make sure that pipe is inserted into screwing crown all the way to the stop.

### Pipes

Corrugated polyethylene pipes and fittings shall be designed to DIN EN 16961, range 5 and prEN 13476 with the class of rigidity SN8 and corresponding ring stiffness values (EN ISO 9969) of minimum 8 kN/m2.

Pipes and fittings shall be double wall; corrugated on the outside and smooth surface on the inside. Pipe couplings shall be with double push-fit socket and EPDM or oil-resistant NBR lip sealing rings. Minimum wall thickness shall be according to prEN 13476. Material properties of pipes and fittings shall correspond to the requirements of prEN 13476. Ring flexibility (capacity for deformation without rupture) shall be at least 30 % according to EN 1446.

Pipes and fittings shall be compatible to the pipes of the sewer lines.

The pipe diameter shall be DN/ID 150.

### Pipe Adapters

For the transition of the different pipe materials pipe adapters as specified by the manufacturer for the selected pipe material shall be used.

For existing PVC property connection pipes:

Pipe adapter PE/PVC 150/150, 150/125, 150/100

For existing AC property connection pipes:

Pipe adapter PE/PVC 150/150, 150/125, 150/100

Plus EPDM pipe collar DN 150/125/100

## Requirements for oil separator to be installed in the stormwater drainage system



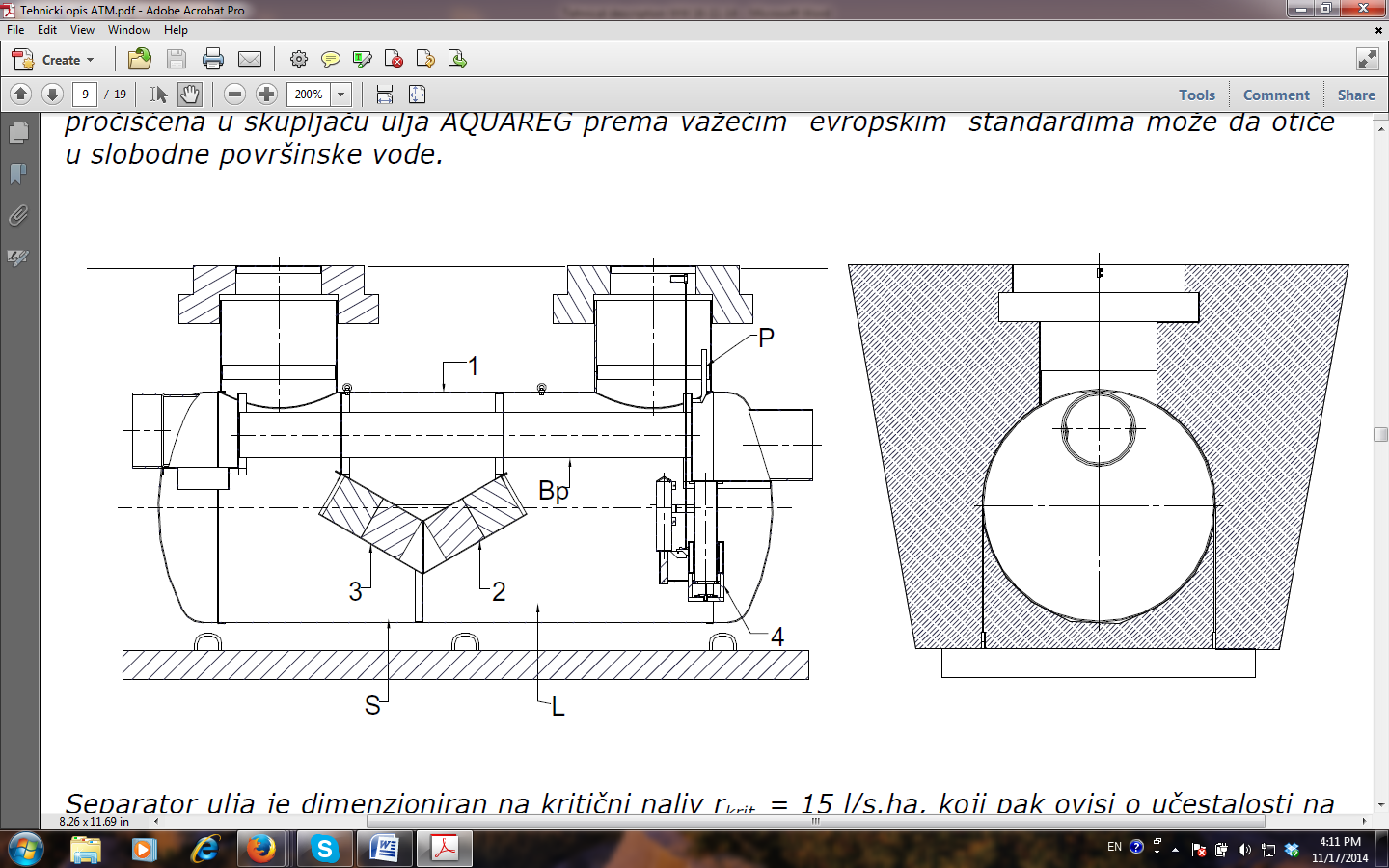
### General

Oil, petrol, gas oil, lubricants and similar liquids have lower specific weight than water, which is used in design of so called oil separators to be installed in the stormwater drainage system. The abovementioned liquids are removed from stormwater discharges in the oil separator. This is achieved by gravity and by using coalescent filters. Another important element in the oil separator is a sludge tank where solid matter is removed. Oil separators are required in public roads, all petrol stations, parking lots, car wash shops, garages, and in similar places where the abovementioned oily liquids can get into stormwater discharges.

### Water treatment in oil separator

Oil separator tank is constructed of reinforced polyester. Influent, i.e. collected stormwater discharge, enters the settling sludge tank where solid matter (like sand, sludge) settles at the tank bottom. Settling process is enhanced by means of lamella plates that are installed in the settling tank. Smaller drops of light, oily matter get separated from water by coalescent filter. The coalescent filter is made of foam or polyethylene plates, on which drops merge and raise to the surface. After passing through the oil separator effluent is discharged via the outlet. Effluent quality must comply with the European standards and must not contain more than 5mg/l of oils.

**Figure 8‑7 – Typical schematic sections of oil separator**



The oil separator is designed to the rain intensity of 15 l/s/ha. For that rainwater intensity, i.e. for the generated discharge, 10% of the discharge is directed through the oil separator and 90% through the by-pass (BP). For the concerned Project Area, the following conclusions have been made:

* Only 8% of all rainfalls is more intensive than 15 l/s/ha
* Only 2.5% of annual rainfall in terms of duration is longer than 15 l/s/ha rainfall
* Only 20% of the total annual rainfall is above the 15 l/s/ha threshold
* It means that most of annual rainfall is treated in the oil separator

### Settling tank (s)

As mentioned before, influent directly enters in the settling tank where solid and heavier matter is settled at the tank bottom.

### Polyethylene plate package (lamella settling tank – 3)

Water with a content of light liquids enters the separator through special polyethylene plates. Drops of oily substances cluster and due to their low specific weight raise to the surface. At the same time polyethylene plate package works as a sludge settling tank because water flow slows down. Very fine sludge is deposited on the lamella plates, which must clean during each emptying of the tank. Design of lamella plates should prevent clogging.

### Oil separator (L)

Polyethylene lamella plate package is installed between the settling tank and the oil separator. The coalescent filter represents the key element of the oil separator.

### Coalescent filter (2)

Smaller drops of light liquids are separated by the coalescent filter. It is a filter made of polyethylene foam or plates, on which drops cluster and raise to the surface.

### Automatic valve at the outlet (4)

At the outlet there is a valve which gets automatically closed as soon as substantial quantity of light, oily liquids is collected by the oil separator. During regular control and maintenance the valve does not get closed. Proper operation of the valve is controlled in relation to the float valve that is also installed in the separator. As soon as app. 400mm of light liquids is separated, the float gets submerged, and the valve should get closed.

### Manhole for taking samples (p)

Sampling of water quality is made by means of the sampling manhole (p) where there is a pipe connection to the outlet pipe.

### Automatic alarm

Automatic alarm device signals submergence of the float valve by 400 mm, i.e. by the maximum allowable height of separated oily substances in the separator.

### By-pass

If the inlet flow is exceeds the capacity of the separator, surplus water is directed to the by-pass.

### General requirements

Oil separator is a device for wastewater treatment separating light liquids, which in terms of size, installation, operation and maintenance is in full accordance with the standard CSN EN 858-2, and as a product is designed, inspected and marked in accordance with the regulations that define these kinds of products.

### Transport and installation of the oil separator with by-pass

### Handling

* It is forbidden to roll and pull the separator.
* Oil separator can be relocated only by lifting.
* Only polyester tapes can be used for lifting, while the use of chains and cables is forbidden.
* Loading and unloading with a forklift is not recommended, while it is forbidden for bigger separators it is forbidden.
* Oil separator must always be placed on a clean and flat base.

### Transportation

* Before transportation oil separator must be cleaned.
* All openings must be temporarily sealed.
* During transportation oil separator must be placed on temporary supports.
* During transportation oil separator must be secured with appropriate polyester tapes to prevent damages.
* It is recommended to install the separator directly from the truck to the foreseen location.

### Temporary storage

* Separator must be stored in a place where the possibility of accidental or intended damage is minimal.
* Surface where the separator will be stored must be flat and clean.
* Separator must be temporarily secured with tapes.
* All openings must be temporarily sealed.

### Installation

Before the installation, i.e. before the selection of the location, it is necessary to check:

* Bearing capacity of soil,
* Groundwater table,
* Foundations of the surround buildings,
* Existing underground utilities (water, electricity, phone etc.).

Working phases:

* selection of the location
* excavation
* preparation of the foundation
* placement of the separator to the foundation
* backfilling to the top of the separator
* connection of the installations
* final backfilling
* levelling

Of present, traffic load should be also taken into account and adequate measures taken.

##### **Placement**

Oil separator should be placed near the source of contaminated water. Normally, separators are buried, but they can be installed as self-standing. Installation in closed areas is not recommended. Separator must be accessible for maintenance and emptying. Under no circumstances oil shall get spilled out of the separator.

##### **Construction of the foundation pit**

The pit must be constructed by an authorized construction company. Dimensions of the pit must be adequate so that the installation of the separator goes smoothly. It means that the size of the pit must be at least 1m wider than the separator. It is necessary to follow all relevant safety and construction regulations.

##### **Vertical oil separator installation**

Oil separator shall be placed in a foundation pit on a reinforced concrete base slab which is 150mm thick. Depth of the pit should be in accordance with sewerage system design and dimensions of the separator. In case that groundwater is present at the site, the separator must be fixed to a concrete block.

Backfilling of pit must be carried out in 200 mm layers with compaction, until the separator is filled to the top.

##### **Horizontal oil separator installation – site without groundwater**

* Construct a reinforced concrete base slab, 200mm thick
* Oil separator is carefully laid to the platform
* Backfill the first layer in the lower of the separator
* Backfilling continues with 200mm thick layers, with compaction, until separator is covered to the top
* The separator should not be filled with water until the backfilling is finished

##### **Installation of the horizontal separator in the presence of groundwater**

When groundwater is present at the site, and may generate uplift and floating of the separator, it is necessary to fix the separator by using reinforced concrete base slab. This will prevent floatation of separator due to uplift pressure. Every separator must have at least two anchors that are marked by the manufacturer. Anchor bands must be made of polyester. Distance between bands must be shorter than the diameter of the separator.

* It is necessary to lower the groundwater table by using drainage pumps, or other appropriate method, as much as possible.
* If it is not possible to lower the groundwater table, the separator must be filled with water
* Lifting belts can be used only for holding the separator in position.
* Backfilling is the same as for dry installation

##### **Pipelines**

All oil separators should be equipped with fixed pipe connections for the inlet and outlet pipes. For the inlet and outlet pipelines standard plastic pipes can be used.

##### **Access covers**

Access covers for the separators must be in accordance with the standard EN124, and shall be of loading class in accordance with the site condition. The access covers should not be ventilated, and should not be fixed by screws.

##### **Quality inspection**

Quality inspection of the separator must be carried out before the backfilling.

The separator is filled up with clean water and observed for 24 hours. There should not be any leakage out of the separator or fittings. Tolerance to leakage is zero. Only after completion of this inspection, the separator can be back-filled.

##### **Backfilling material**

For backfilling granular material like sand and gravel with grain size of 3 to 20mm should be used. Backfilling material shall be uniformly distributed around the separator, with proper compaction. Additional compaction can be achieved by means of a mechanical vibrator, however due care should be taken in order not to damage the separator.

For filling can be used materials such as sand or gravel, granulation between 3 and 20 mm. Filling material must be equally distributed around separator. It can be compressed with mallet. Extra compression can be performed with mechanical vibrators, whereby it is necessary to look out so the separator won’t get damaged.

### Commissioning

After the installation and before putting the separator into operation, the separator should be thoroughly cleaned and rinsed with clean water. Once the separator is cleaned, it is important to set the automatic valve at the outlet pipe of the separator.

Parts of the separator can be cleaned only by means of certified bio-degradable chemicals for de-greasing.

# Road works



## Removal of existing road pavement

The Contractor shall cut and break open the existing pavement, including curb stones, as required for the sewer and road construction, load, transport and dispose of the material according to the respective regulations. Disposal certificates need to be submitted to the Engineer.

Where pipes have to be laid under existing paved areas such as roads or sidewalks, cutting into the pavement shall be done with appropriate tools, to ensure straight and neat cuts, widening at chambers shall be done at right angles.

In order to ensure that paved surfaces are not undermined by local slippages of trench walls, the pavement shall be cut to a width of 0.60 meters (0.30 meters each side), greater than the net width of trench as indicated on the Drawings. First cutting shall be in the width of the pipe trench. The second cutting (trench width + 30 cm at each side) shall be carried out directly before compaction of the gravel/macadam road base and reinstatement of the paving.

Remaining surfaces of 30 cm or less at the border to the sidewalk should be removed with the approval of the Engineer.

All demolition material is transferred to the property of the Contractor. Impurities caused by the cut or the demolition are to be cleared by Contractor.

The costs for cutting, break open and removal of the road surface shall be included in the item for the reinstatement of the road paving. The Contractor shall include in his price the required widening up at chambers.

The straight cut on the existing bitumen coating layer at distance of 30 cm from the previous cut using cutter to 10 cm deep shall be included in the tender price item for the installation of the final asphalt layer.

The price for removal of tarmac surface shall include also the disposal of the waste.

## Construction and reinstatement of road pavements

In general the road pavement shall be reinstated with the same type as the existing paving. The existing type of road pavement is indicated in the Drawings.

Road surfaces shall be reinstated to a clean and level condition.

Materials, thickness of layers and degree of compaction of all road works shall be as set forth in these Specifications.

Road base material shall be filled to final road surface level. Only directly before the compaction of the macadam/gravel road base and construction of the asphalting wearing and base layers, the top of the road base shall be removed in a thickness as required for the applicable paving type (e.g. 10 cm for asphalt paving).

Permanent reinstatement of all other surfaces (green areas, footpaths, sidewalks, and pavements) shall be carried out immediately after backfilling.

Where excessive subsidence to the reinstated surface occurs, the Contractor shall reexcavate the trench to sufficient depth to re-compact the backfill material and reinstate the surface at his own expense. Excessive subsidence shall be defined as settlement of the surface exceeding 10 mm with respect to the existing, adjacent undisturbed surface.

Finished surfaces at each stage of road construction shall not vary from the levels described in the contract by more then the following permissible deviations:

Surface Permissible deviation (mm)

Formation and sub-base +10 -30

Base ±15

Wearing surface or slab surface ± 6

The combination of permitted tolerances in the levels of different pavement courses shall not result in a reduction in thickness of the pavement, excluding the sub-base, by more than 15 mm from the specified and the maximum allowable irregularly of the wearing surfaces below a 3 m straight edge shall be 3 mm.

Within 48 hours of completion of a road formation, granular road or sub-base material shall be spread and compacted to the required thickness. The road and sub-base shall be protected from deterioration due to ingress of water, the adverse effects of weather and the use of Contractor's Equipment. Compaction shall be carried out in accordance with the figures below.

The Contractor shall construct and reinstate the road pavement after construction of the sewer pipes and manholes according to the following specifications:

Asphalt road:

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Asphalt wearing and base course (single layer) | 10 |  |
| Frost protective gravel/macadam road base | 35 | 100 |
| Sub-base layer/Subgrade |  | 45 |

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Asphalt concrete wearing course | 5 |  |
| Asphalt base course | 7 |  |
| Frost protective gravel/macadam road base | 33 | 100 |
| Sub-base layer/Subgrade |  | 45 |

Concrete block paving (road):

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Concrete paving blocks 200x100x80 mm | 8 |  |
| Sand bedding layer (grain size range: 0-4 mm) | 3 |  |
| Frost protective gravel/macadam road base | 41 | 120 |
| Sub-base layer/Subgrade |  | 45 |

## Sub-base

The Contractor shall supply and refill trenches with soil that is compactable and does not contain slimy, perishable material or vegetable matter. The granular sub-base shall consists of healthy and strong minerals and be free of any organic components.

The provision and filling of the sub-base material the supply of the soil, placing in layers, adjusting of moisture content, compaction and the trimming of compacted surfaces.

Suitable excavated material shall be loaded and transported from the intermediate storage on the Site and the trench shall be filled as specified.

A degree of compaction of 97 % is required for trenches in roads. Outside of roads a degree of compaction of 95 % is required.

For trenches in roadways or other paved areas the backfill shall be brought up to formation level, or sub-formation level in preparation for road reinstatement works. Where trenches are in roadways, the Contractor shall protect the pipes from moving loads after their laying, during the completion of the road works. Any pipes damaged after their laying shall be replaced and the Contractor shall be liable for all expenses and delays caused.

The subgrade, immediately before being covered with road base material, shall be clean, free from mud and slurry and properly shaped and compacted to an even and uniform surface. The subgrade at the top of the sub-base shall be compacted to a modulus of elasticity of at least 45 MN/m2.

Where backfill is to be placed on two or more sides of the structure, it shall be placed simultaneously on the opposite sides so that the difference in level never exceeds 0.30m, or as otherwise instructed.

Backfill to structures shall generally be carried out as soon as practicable. All material used in backfill shall be compacted with suitable approved mechanical equipment in layers not exceeding 150 mm in depth before compaction. All material used in backfill shall be placed at ±2% of the optimum moisture content to achieve compaction results of not less than 97% Modified Proctor test.

The Contractor shall carry out tests (i.e. plate load test acc. to DIN 18134) to verify the specified degrees of compaction. In situ density tests of compacted backfill material shall be carried out on minimum two samples for every 100 m stretch of pipe. Quality certificates for the compaction samples shall be presented at the work commissioning. The Contractor shall be responsible in all cases for any settlement of the backfill and shall make good at his own expense such settlement or damage to structures resulting from such settlement.

## Macadam/gravel road base

The Contractor shall ensure that the layers of macadam, gravel, ballast are very well compacted.

The Contractor shall ensure that the macadam layer is thoroughly cleaned prior to placing the final surfacing.

Composition of the road base shall comply with the German Standard ZTVT-StB 95. Grain sizes shall be well-sorted and comply with configuration 0/56 mm as stipulated in the above standard. The contents of fine particles below 0.063 mm shall be less than 7.0 weight - %. During the construction, attention shall be paid to the uniformity of the material and the optimal water contents. Segregation of the grain fractions must be avoided.

Before placing the base course, the refilled soil shall be levelled and compacted to a Proctor density of 100%. The soil shall be kept at the required moisture content.

The ballast support layer shall be prepared as combined frost protection gravel / macadam layer with a thickness as indicated in these Specifications, a maximum deviation of the sub grade surface of ±2 cm and a module of deformation of Ev2≥100 MN/m² respectively Ev2≥120 MN/m². The compaction shall be DPr 100%.

The Contractor shall carry out tests (i.e. plate load test acc. to DIN 18134) to verify the specified degrees of compaction. In situ density tests of compacted backfill material shall be carried out on minimum two samples for every 100 m stretch of pipe. Quality certificates for the compaction samples shall be presented at the work commissioning. The Contractor shall be responsible in all cases for any settlement of the backfill and shall make good at his own expense such settlement or damage to structures resulting from such settlement.

## 



## Construction and reinstatement of asphalt road pavement

### General Description

This work consist of performing all operations and furnishing all materials, labour, tools, equipment and appurtenances that may be required to construct the roadways, parking and other facilities as indicated on the Drawings, as specified herein and/or included in the Bill of Quantity.

The placing of asphalt material shall be performed as a continuous operation, unless otherwise dictated by the Engineer.

The mixing and placing of the asphalt shall progress at a rate so that contamination of previous asphalt work by dust/dirt or loss of bonding capability shall not occur.

In case of a breakdown in the plant or other emergency it shall made impossible to carry out this requirement, or if more than 48 hours has elapsed between asphalt placement operations, a prime coat or tack coat complying with this Specifications, or as directed by the Engineer, shall be applied to the surface at no additional cost for the Client.

### Storage and materials handling

Materials shall be stored and handled so as to assure the preservation of their quality and fitness to the work. Materials even though approved before storage or handling, may again be inspected prior to use in the Work.

### Inspection, testing and control of materials

For verification of weights and measures, character of materials, and determination of temperatures used in the preparation of the asphalt mixes, the Engineer shall at all times have access to all portions of the plant, aggregate production plant, storage sites, crushers and all facilities used for the production and processing of the materials. The Engineer will have authority to take samples and perform tests on any material supplied to the Site from any source whatsoever in order to establish their compliance with these Specifications and to accept or reject as he deem necessary. Materials that do not comply with the requirements of these Specifications shall be removed immediately upon rejection from the Site of Works.

### Sources of materials

The materials used in the works shall be tested and approved before use. The Contractor shall notify the Engineer of the sources of materials and the Engineer shall approve the sources prior to delivery of materials to the Site. In case the source of material does not meet the Specification requirements, the Contractor shall provide material from different sources.

### Asphalt cement

The asphalt cement shall meet the following requirements of German Standard ZTV-Asphalt-StB “Additional technical specifications and guide lines for asphalt in road construction“:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | | | Type of asphalt (Penetration grade) | | Test according to |
| 50/70 | 70/100 |
| Needle penetration (100g, 5 s, 25 °C) | | 0.1 mm | 50 – 70 | 70 - 100 | DIN EN 1426 |
| Ring & Ball Softening Point | | °C | 46 – 54 | 43 – 51 | DIN EN 1427 |
| Softening Point (German restriction) | | °C | (48 – 54) | (43 – 49) |  |
| Resistance to hardening at 163 °C | |  |  |  | DIN EN 12607-1/3 |
|  | Maximum change in mass ± | % | 0.5 | 0.8 |  |
|  | Remaining penetration, minimum | % | 50 | 46 |  |
|  | Softening point after hardening, minimum | °C | 48 | 45 |  |
| Flash point, minimum | | °C | 230 | 230 | DIN EN 22592 |
| Solubility, minimum | | % | 99.0 | 99.0 | Din EN 12592 |
| Paraffin contents | | % | 2.2 | 2.2 | DIN EN 12606-1 |
| Breaking point (Fraaß), maximum | | °C | -8 | -10 | DIN EN 12593 |
| Increase of the softening point after hardening, maximum | | °C | 9 | 9 |  |

The asphalt cement shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 175o C. Blending of asphalt cement materials from different sources will be not permitted without the Engineer’s approval.

### Asphalt works equipments

The machinery and tools utilized in construction of Asphalt works shall be in reasonable working condition. The Engineer shall approve the machinery and tools prior to the commencement of work, and the Contractor shall supply adequate quantity of such machinery in order to execute the work with the due speed and precision.

### Hauling equipment

Vehicles used for transport of aggregates or bituminous mix shall have tight, clean and smooth metal beds and shall be free from dust, screenings, petroleum oil, volatile or other mineral spirits which may affect the material being hauled.

Use of diesel or other solvents to spray in the truck bed is prohibited. Lime water, soap or detergent solution shall be used to prevent bituminous mix from adhering to the bed.

### Spreading and finishing equipment

The equipment for spreading and finishing the asphalting mixture shall be of an approved type, capable of spreading and finishing the mixture true to line, grade and required crown.

The paver shall be equipped with hoppers and distributing screws of the reversing type to place the mixture uniformly in front of adjustable screeds.

The paver shall be designed to allow a maximum width of paving not less than 3 meter, reducible to 2 meters. The paver shall be also equipped with such provisions and attachments to suit the paving width specified as well as paving on sloped sections.

Screed shall include feed controls to maintain a constant level of material along the full length of the screed, profile grade control and slope control. The profile grade control shall be activated by a travelling articulated averaging beam of appropriate length or by taut stringline (wire) set to grade. The slope control shall be equipped with a proportioning manual override to enable smooth transition of changing slope rates. Screed controls shall be approved by the Engineer prior to use.

If during construction it is found that the spreading and finishing equipment may leave in the pavement during operation surface tracks or indented areas or other objectionable irregularities, the use of such equipment shall be discontinued and other satisfactory equipment provided by the Contractor at his own expenses.

### Rollers

Rolling equipment shall consist of vibratory steel-wheeled rollers, steel wheel rollers and pneumatic-tired rollers as required by the Engineer for proper compaction and finishing of the asphalt surface.

Steel-wheeled rollers shall be two-axle tandem rollers and three-axle tandem rollers. These rollers shall each two-axle roller shall have a minimum weight of 89 kN; each three-axle roller shall have a minimum weight of 116 kN.

Rollers shall be equipped with adjustable scrapers to keep the wheel surface clean. Rollers shall be also equipped with efficient means of keeping them wet to prevent mixes from sticking. Vibratory steel wheeled rollers shall have dual drums with a minimum weight of 62 kN. Vibrating frequency shall be between 2000 and 3000 cycles per minute with individual controls for each tandem.

### Asphalt distributor

The asphalt distributor truck shall be of the pressure type with insulated tanks. The use of gravity distributors will be permitted only for very narrow trenches where asphalt cannot be distributed by means of equipment and has to be distributed manually instead. The distributor shall have pneumatic tires of such width and number that the load produced on the road surface shall not exceed 98 kN per meter of width. Spray bars shall have a minimum length of 3 meters and shall be of the full circulating type. Spray bar extensions shall also be of the full circulating type. The spray bars shall be adjustable to maintain a constant height above the surface to be treated. The spray bar nozzles shall be slotted and shall be of such design so as to provide a uniform unbroken spread of bituminous material on the surface. A uniform application of bituminous material, in controlled amounts, may be made ranging from 0.15 to 5.0 Kg/m2. Prior to the work’s commencement the bituminous distributor shall be checked and calibrated to grant transverse and longitudinal spread variation not exceeding 10% from the required rate.

### Bituminous Base course and Wearing course

### General

The work shall consist of constructing an asphalt concrete paving course on a prepared surface in accordance with the Specifications and in compliance with lines, grades, thicknesses and typical X-sections indicated in the Drawings or as directed by the Engineer.

### Bituminous mixes

The types of shall be as specified on the Drawings and shall comply with the composition shown in the following table.

The asphalt concrete mixes for the asphalt wearing course shall meet the following requirements to German Standard ZTV-Asphalt-StB “Additional technical specifications and guide lines for asphalt in road construction“*:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Asphalt concrete** | | | 0/11 |
| 1. | Grain sizes |  | High-quality crushed stone, high-quality crushed sand, natural sand, rock flour |
|  | Grain size configuration | mm | 0/11 |
|  | Grain size < 0.09 mm | M.-% | 7 - 13 |
|  | Grain size > 2 mm | M.-% | 40 - 60 |
|  | Grain size > 5 mm | M.-% | - |
|  | Grain size > 8 mm | M.-% | ≥ 15 |
|  | Grain size > 11.2 mm | M.-% | ≤ 10 |
|  | Grain size > 16 mm | M.-% | - |
| 2. | Asphalt binding material |  |  |
|  | Class of binding material |  | 70/100 |
|  | Asphalt binder contents | M.-% | 6.2 – 7.5 |
| 3. | Asphalt mix |  |  |
|  | Marshall-test sample compaction temperature | °C | 135±5 |
|  | Voids contents | Vol.-% | 1.0 – 3.0 |
| 4. | Layer |  |  |
|  | Installed thickness or | cm | 3.5 – 4.5 |
|  | Installed weight | kg/cm2 | 85 - 115 |
|  | Degree of compaction | % | ≥ 97 |
|  | Voids contents | Vol.-% | ≤ 6.0 |

The asphalt concrete mixes for the asphalt base course shall meet the following requirements to German Standard ZTVT--StB “Additional technical specifications and guide lines for base courses in road construction“:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Asphalt concrete mix | Grain size configuration | Grain size > 2 mm | Grain size > 0.9 mm | Course grain minimum | Oversize grain maximum | Minimum bitumen contents | Marshall stability at °C minimum | Marshall coefficient of flow | Voids contents of Marshall test sample |
| - | mm | M.-% | M.-% | M.-% | M.-% | M.-% | kN | mm | Vol.-% |
| AO | 0/2 to 0/32 | 0 - 80 | 2 - 20 | 10 | 20 | 3.3 | 2.0 | 1.5 – 4.0 | 4.0 – 20.0 |

The combined asphalt wearing and base course shall be constructed to German Standard ZTV-Asphalt-StB “Additional technical specifications and guide lines for asphalt in road construction“ and meet the following *requirements:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Mix for the asphalt wearing/base course** | | | 0/16 |
| 1. | Grain sizes |  | Crushed stone and/or gravel, crushed sand and/or natural sand, rock flour |
|  | Grain size configuration | mm | 0/16 |
|  | Grain size < 0.09 mm | M.-% | 7 - 12 |
|  | Grain size > 2 mm | M.-% | 50 - 70 |
|  | Grain size > 11.2 mm | M.-% | 10 - 20 |
|  | Grain size > 16 mm | M.-% | ≤ 10 |
| 2. | Asphalt binding material |  |  |
|  | Class of binding material |  | 70/100 |
|  | Asphalt binder contents | M.-% | ≥ 5.2 |
| 3. | Asphalt mix |  |  |
|  | Marshall-test sample compaction temperature | °C | 135±5 |
|  | Voids contents | Vol.-% | 1.0 – 3.0 |
|  | Marshall stability | kN | ≥ 4.0 |
|  | Marshall-Flow coefficient | mm | 2.0 – 5.0 |
| 4. | Layer |  |  |
|  | Installed thickness or | cm | 10 |
|  | Installed weight | kg/cm2 | 250 |
|  | Degree of compaction | % | ≥ 96 |
|  | Voids contents | Vol.-% | ≤ 7.0 |

In order to proof the suitability of the proposed asphalt mix the Contractor shall provide information about its composition and about the tests carried out in the frame of the initial type testing conducted by an authorized laboratory.

The Contractor shall submit a statement about the suitability of the asphalt mix for the intended purpose.

Asphalt shall meet the requirements of DIN EN 13108.

The material for asphalt concrete shall be combined as to be well graded within the limits given in the table.

The Contractor shall submit a proposed job mix formula together with all applicable design data at least one month prior to commencement of Works. The Engineer will take samples of the materials proposed for use in order to check their quality and to check the proposed mix design or to prepare a new mix design. The Engineer will then issue an approved job mix formula with characteristics and composition that shall be supplied by the Contractor. The approved job mix formula will give a combined gradation showing a single definite percentage passing each sieve as well as percentage of each material to be used in the mix. The job mix formula will also establish the mixing temperature and a compaction reference density.

Approval by the Engineer of the job mix formula shall in no way relieve the Contractor of his responsibilities and obligations stipulated in the Contract and the Contractor shall be responsible for the soundness of the asphalt paving mixes and the satisfactory execution and performance of the asphalt paving courses.

Samples of loose asphalt concrete mix shall normally be taken behind the paver before compaction and shall be obtained in accordance with AASHTO T-230. Samples of compacted asphalt concrete shall be obtained by coring in accordance with Method B of AASHTO T-230.

Determination of bitumen content and extraction gradation may be performed on either loose or compacted samples in accordance with AASHTO T-164 and AASHTO T-30 or similar, except that the ash correction shall be determined by using a bitumenometer. The specific gravity of the compacted asphalt concrete cores will be measured in accordance with AASHTO T-230 or similar.

### Construction requirements

Weather limitations

Production and spreading of asphalt concrete shall not be permitted when the ambient temperature is less than 8oC and more than 40°C, nor during rain, snow, fog, dust storms or other unsuitable weather, or in any case as instructed by the Engineer. The Contractor shall ensure adequate protection of the asphalt sheets in the event of bad weather.

Equipment

The equipment required shall be the one specified under the chapter «Asphalt work equipment» of these Specifications. Intermittent or «stop&go» type of operations will not be permitted.

Survey and areas preparation

The area to be paved shall be true to lines and grades indicated on the Drawings or established by the Engineer and shall have a properly prepared surface prior to the start of paving operations. Priming or tacking of surface to be paved shall be in accordance with the relevant chapters of these Specifications, «Prime Coat» or «Tack Coat».

The surface of curbs, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin and complete coating of tack coat as instructed by the Engineer to provide a closely bonded, watertight joint.

All openings or structures in the road for water, drainage and other specified utilities shall be constructed and their position and levels determined before the start of paving operations.

Asphalt concrete mix preparation

Asphalt cement shall not be used if foaming occurs nor shall it be heated above 177oC at any time. All materials involved in Asphalt concrete production should be in line with these Specifications and approved by the Engineer before incorporation into the work.

The mix temperature shall be within the limits set out in the job mix formula when emptied from the mixer, but in no case shall exceed 160oC.

Delivery of the asphalt concrete mix

The dispatching of the hauling vehicles to the job site shall be so scheduled that all material delivered may be placed in daylight, unless the Engineer approves the use of artificial light. The mix shall be delivered to the paver at a temperature between a minimum of 120oC and a maximum of 160oC.

Spreading and finishing

The mix shall be laid upon an approved surface produced in accordance with chapter «Survey and areas preparation» of these Specifications and only when weather conditions are suitable (see chapter Weather limitations of these Specifications).

Upon arrival at the point of use, the asphalt mix shall be spread and struck off to the grade, elevation and x-section shape intended, either over the entire width or over such partial width as may be required.

In no case shall construction of a new asphalt concrete course (Type) begin until the previously laid course has been tested and approved in accordance with these Specifications.

Compaction

At least 2 rollers shall be required at all times:

Additional rollers may be added, upon Engineer’s instruction, at no extra cost for the Client, if so deem necessary to reach the specified asphalt course density and surface characteristics in an orderly, efficient and continuous manner. The rollers shall move at a slow but uniform speed with the drive wheels nearest the paver. The speed shall not exceed 4.8 km/h for steel wheeled rollers or 8.0 km/h for pneumatic-tired rollers. Heavy equipment or rollers shall not be permitted to stand on the finished surface before it has been compacted and has thoroughly cooled.

Edges

The edges of the asphalt course shall be rolled concurrently with or immediately after rolling the longitudinal joint.

Protection

Sections of the newly finished work shall be protected from traffic of any kind until the mix has been properly compacted and cooled. In no case shall traffic be permitted less than 12 hours after completion of the asphalt course.

Testing

Each completed asphalt concrete course (Type) shall be tested and approved prior to placing any subsequent asphalt concrete course. The Contractor shall, at his own expense, cut samples from each completed asphalt course during the progress of the work and before final acceptance of the project, all as directed by the Engineer. Compacted samples shall be taken by coring in accordance with AASHTO T-230 or similar. Hot asphalt mix shall be placed and compacted in holes left by sampling.

Compaction requirements

The minimum degree of compaction required for the various types of asphalt concrete, expressed as a percentage, shall be as indicated in these Specifications.

### Prime Coat

### General

This work shall consist of furnishing and applying liquid asphalt prime coat to previously prepared and approved absorbent surfaces.

### Material

Liquid asphalt shall be of the curing type MC-70 grade. The application rate shall be between 0.25 and 0.50 kg/m2 as indicated on the Drawings or as directed by the Engineer.

### Construction Requirements

Weather Limitations

Prime coat shall not be applied when the ambient temperature is less than 13ºC nor during rain, snow, fog, dust-storms or other unsuitable weather.

Application Temperature

The application temperature for the MC-70 liquid asphalt shall be between 60ºC and 85ºC as directed by the Engineer.

Equipment

The equipment used by the Contractor shall include asphalt distributor motor graders, rollers, water trucks, and other related equipment shall also be provided.

Surface Preparation

Immediately before applying the prime coat, all loose dirt, earth and other objectionable material shall be removed from the surface and any dust, soft spots or unacceptable irregularities in the surface.

Work’s Methodology

After preparing the road surface as above, the liquid asphalt shall be applied by means of the distributor at the temperature and rate directed by the Engineer. Hand-spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer.

The prime coat shall be uniformly applied with the distributor within a maximum of 48 hours preceding placement of asphalt concrete paving.

Maintenance and Traffic

Traffic shall not be permitted on the primed surface until the asphalt material has penetrated and dried.

### Tack coat

### General

This work shall consist of furnishing and applying slow setting emulsified asphalt tack coat to a previously placed asphalt base course.

### Material

Emulsified asphalt shall comply with the requirements of clause “Liquid and Emulsified Asphalt” of these Specifications. The approved emulsion will be diluted with approximately an equal quantity of water and thoroughly mixed as directed by the Engineer. The diluted emulsion shall be applied at a maximum rate of 0.50 kg/m2 as indicated on the Drawings or as directed by the Engineer.

### Construction Requirements

Weather Limitations

Tack coat shall not be applied when the ambient temperature is less than 13ºC nor during rain, snow, fog, dust-storms or other unsuitable weather.

Application Temperature

The application temperature for the diluted emulsified asphalt shall be between 10ºC and 60ºC as directed by the Engineer.

Equipment

The equipment used by the Contractor shall include an asphalt distributor in accordance with clause “Asphalt Distributor” of these Specifications. In addition, the Contractor shall supply and utilize efficient and approved equipment for diluting the emulsified asphalt with water and a power broom.

Surface Preparation

The full width of the surface to be treated shall be cleaned to remove dust, dirt or other objectionable materials. The surface shall be dry when treated.

Work’s Methodology

Immediately after cleaning the surface, the diluted emulsified asphalt shall be applied by means of the distributor at the temperature and rate directed by the Engineer. Hand spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer. Where, in the opinion of the Engineer, a tack coat is not necessary between layers of freshly placed courses, he may, by written direction, eliminate the tack coat in which case there will be no payment for tack coat for the areas concerned. Any cleaning required in these areas shall be considered to be included in the overlaying asphalt concrete course and no separate payment will be made.

## Concrete paving blocks



### General Description

This work consist of performing all operations and furnishing all materials, labour, tools, equipment and appurtenances that may be required to construct the roadways, parking and other facilities as indicated on the Drawings, as specified herein and/or included in the Bill of Quantity.

Concrete paving blocks shall be manufactured to DIN EN 1338.

### Subgrade

Before applying the road base, the subgrade must always be free of water and compacted to a modulus of elasticity of at least 45 MN/m2.

### Frost protective gravel/macadam road base

The execution of the road base shall be as described in these Specifications. The road base must have an even and a properly closed surface. It is absolutely necessary:

* to remove any unevenness greater than 1.5 cm. Usually it is a requirement that unevenness measured with the 3m straightedge may not exceed 1 cm;
* to provide the necessary transverse slope. For concrete block pavements usually a transverse slope of at least 2.5 % is required.

Only in this way a laying course with a uniform thickness can be achieved.

### Curb stones and gutter stones

Curb stones and gutter stones shall be placed before applying the laying course as indicated on the Drawings. The permissible deviations in the size of the blocks delivered must be taken into account for placing of the concrete paving blocks in order to avoid cutting and sawing.

### Laying course

The behaviour of the block pavement depends to a significant degree on the quality of the laying course. A laying course serves on the one hand to cushion the small unevenesses in the sub-base and any slight deviations in the thickness of the blocks, and on the other hand makes it possible to compact the blocks properly and keep them in place.

That is why the ideal laying course is a slightly elastic and stable layer. It is uniform in thickness, which after compaction is 3 to 4 cm thick. It is not deformed by traffic, nor by fluctuations in the moisture content. In addition, it must be relatively porous for most applications, so that no water can stagnate between the blocks and the laying course.

### Materials for the laying course

Taking into account the above requirements, the following materials qualify:

* For ordinary streets and squares with moderate traffic, well graded, sharp, coarse sand 0/4 can be used, that preferably contains less than 3 % fine elements smaller than 0.080 mm.

### Applying of the laying course

If the laying course is applied on a stony subbase, then the top of that subbase must be properly closed, which shall be done by compacting in fine material and/or washing it in. If not, this can later give rise to unevenness in the pavement. To achieve a laying course with a uniform thickness of 3 to 4 cm after compacting, in general 4 to 5 cm of non-compacted material must be spread out, depending on the nature and moisture content of the materials. The bedding sand itself shall not be compacted. When compacting the blocks placed, indirect compacting shall be used.

### Applying and finishing of the block pavement

This involves placing the concrete blocks next to each other on the laying course and fixing them.

### Placing of the concrete blocks

The paving pattern shall be 90° Herringbone.

The concrete blocks shall be placed tightly against each other on the profiled laying course. Blocks shall be laid in such a way that narrow joints of about 2 mm are obtained. While laying, the alignment of the blocks shall be regularly checked with a string to make corrections where necessary.

Concrete blocks from different packages shall be used at the same time, so that any differences in colour are less noticeable.

Laying shall occur from on top of the blocks that have been placed in order to avoid disturbing the laying course.

Work shall start at the edges, preferably with entire blocks. Openings shall be filled up with filling blocks cut to size, that should not be smaller than half a block. Mechanical placing of the blocks is recommended. In order to avoid puddles of water on the sides, the blocks must be placed in such a way that after compacting they are still 5 to 10 mm higher than the gutter elements.

### Fixing of the concrete blocks and filling of the joints

When any openings have been filled, the blocks are fixed. This shall be accomplished with vibratory plate compactors with a rubber or plastic sole. In this way the blocks are pressed into the bedding sand, whilst any unevenness is eliminated.

Before starting with the compacting, the surface of the blocks and the plate compactor has to be cleaned. Compacting always occurs from the edge to the middle of the pavement. In addition, the compacting is kept at least 1 m from the zone where the blocks are still being laid. The evenness is measured with a 3 m straightedge. Any unevenness of more than 5 mm is not accepted and has to be corrected by relaying the blocks. Differences in height between adjacent blocks may normally not exceed 2 mm. This applies especially to blocks without bevelled edges, for which even the smallest irregularity will be noticeable in skimming light. Any damaged blocks shall be immediately replaced. When compacting has been carried out a number of times, fine, dry sand 0/1 with less than 10 % fine elements smaller than 0.080 mm, or crushed sand shall be swept into the joints.

In dry weather the surface must be kept moist for a few days, in order to guarantee that the joints are properly and durably filled. Filling the joints with sand and compacting is repeated until the blocks are completely fixed. Filling the joints shall be facilitated by washing the sand into them.

The Contractor shall clear site of all debris and rubble on completion and make good.

Empty or badly filled joints shall be topped up with sand a few weeks after carrying out the work.

### Construction Requirements

*Weather Limitations*

Applying of road base and laying course as well as the placing of the concrete paving blocks shall not be carried out when the ambient temperature is less than 0ºC.

## Unpaved roads

Road base material shall be filled to final road surface level.

## Footpath

This work consist of performing all operations and furnishing all materials, labour, tools, equipment and appurtenances that may be required to construct and reinstate the footpaths as indicated on the Drawings, as specified herein and Chapter 9 and/or included in the Bill of Quantity.

Concrete paving blocks:

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Concrete paving blocks 200x100x80 mm | 8 |  |
| Sand bedding layer (grain size range: 0-4 mm) | 3 |  |
| Frost protective gravel/macadam layer | 19 | 80 |
| Subgrade |  | 45 |

Asphalt wearing course:

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Asphalt wearing course | 8 |  |
| Frost protective gravel/macadam layer | 22 | 80 |
| Subgrade |  | 45 |

Concrete wearing course:

|  |  |  |
| --- | --- | --- |
| Layer | Thickness of Layer [cm] | Modulus of Deformation Ev2 [MN/m2] |
| Concrete wearing course | 12 |  |
| Frost protective gravel/macadam layer | 18 | 80 |
| Subgrade |  | 45 |

The surface of the pavement shall be sloped with an inclination of 2.5 % for the discharge of surface water. Footpaths shall be enclosed with concrete curbstones (edging stones) 5 x 25 cm laid in a concrete bed.

## Curb Stones

Where indicated on the drawings the road shall be enclosed with concrete curb stones DIN 483 15x30 cm laid on a concrete bed Grade C20 (thickness: 20 cm). Raised curb stones shall be used on both sides of the road.

Precast Concrete Curbs shall be furnished as detailed on the Drawings and shall be installed to the lines and grades indicated in the same Drawings or as directed by the Engineer.

Flush curb stones shall be used for driveways.

Curved curb stones and curb stones for the transition raised/flush shall be included in the unit price.

Curb stones shall be butt-jointed except where otherwise described in the Specifications. All curbs shall be backed with Grade C20 concrete.

For radii of 12 m or less, curbs of the appropriate radius shall be used or reduced up to 20 cm long to be laid in curves.

Alignment of curbs and channels shall not deviate from that described in the Contract by more than 10 mm, with no lapping of visible faces.

Precast Concrete Curbs shall be homogeneous elements 50-60 cm long. Edges shall be sharp without flanges and lippings. The upper surface shall be finished true and smooth.

Precast Concrete Curbs shall be laid as indicated on the Drawings and shall be fixed prior to constructing the road pavement, but after Crushed Aggregate Base Course laying and compacting.

Precast Concrete Curbs shall be fixed on a concrete foundation of dimension, grade and line as indicated on the Drawings.

The Contractor shall provide all the necessary form work to construct the foundation to the size and shape indicated.

# Storm Overflow Equipment



## Scum Board

The overfall shall have a scum board made of stainless steel (Material-No. 1.4571) according to DIN 19558 to provide a uniform overflow.

## Dentated Sill

The overfall shall have a dentated sill as scarifier to avoid flow fluctuations. The dentated sill shall be stainless steel (Material-No. 1.4571).

## Flap valve

The flap valve shall be HDPE/PP, nominal diameter DN/ID 600, with elastomer lip sealing, according to DIN EN 1852, ring stiffness SN 10, with socket joint, suitable for connection to the sewer pipes as specified herein.

# Cleaning of the site

The Contractor is responsible for cleaning the site and the adjacent areas, complying with the provisions of the Local Authority (City Hall). After finishing all the work, the Contractor shall clean up the site, by removing any objects, soil heaps, obstacles, etc., which would cause inconvenience. The site should be free of rubbish, dust and dirt. The Contractor shall restore the site to the conditions existing prior to commencement of the Works.