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17 ROAD DRAINAGE

17.1 GENERAL REQUIREMENTS

17.1.1 Scope

- 1 This Part includes:
 - (a) stormwater drainage works draining the road carriageway and directly adjacent areas, including:
 - (i) road and other pavement gullies and gully pots
 - (ii) pipes of minimum 150mm diameter including bedding materials used to connect gully pots to inspection chambers and intermediate manholes
 - (b) groundwater drainage using filter drains within the road corridor
 - (c) soakaways specifically related to road stormwater and groundwater collection and disposal
 - (d) connections to stormwater drainage systems including culverts, open channels and closed stormwater drainage pipelines.
 - (e) Geocellular attenuation and soakaway trenches and tanks.
- 2 Related Sections and Parts:

This Section

Part 18..... Geosynthetics

Section 5 Concrete

Section 8 Drainage Works

Section 20 Drainage Works for Buildings

Sec 20,Part 3 .. External Drainage Works

17.1.2 References

- 1 The following standards are referred to in this Part:

BS 4962.....Plastic pipes and fittings for subsoil drainage

BS 5911.....Concrete pipes ancillary concrete products

EN 124Gully tops & manhole tops for vehicular and pedestrian areas

ISO 14654Epoxy coated steel

ISO 9001Quality management systems

BRE digest 365 - Soakaway Design

17.1.3 Quality Assurance

- 1 The manufacturer of all manholes and gully gratings shall be accredited to a third party quality system such as ISO 9001. The supplier shall submit a copy of his accreditation showing the scope of products covered.

17.1.4 Delivery, Storage and Handling

- 1 All manhole covers and gullies shall be clearly marked with the technical standard of manufacture, the loading class, the name identification mark of the manufacturer and the mark of the certification body.

17.2 DRAINAGE PIPES & PIPELINES

- 1 The materials, manufacture, finish, installation inspection and testing of all drainage pipes and fittings for roadworks shall comply with the requirements of Part 3 of Section 20, except as modified by this section of the specification.
- 2 The type of pipe to be used and the diameter shall be as designated on the drawings or in the project specification.
- 3 Pipes may be of vitrified clay, concrete, glass reinforced plastic or UPVC. Each of these pipe types shall meet the designated requirements for standards, materials, manufacture, strength, length and dimension of tolerances joints, workmanship and finish, inspection and basis of acceptance given in Part 3 of Section 20.
- 4 Unless designated otherwise only one type of pipe shall be used within any individual drain or service duct between consecutive chambers.
- 5 The Contractor shall ensure that plastic pipes are not subject to deterioration due to exposure to sunlight between manufacture and installation in the ground.
- 6 The excavation, bedding, laying and backfilling around pipelines shall be carried out in accordance with Part 2 of Section 8.
- 7 Soft spots below the bottom of an excavation shall be removed as directed by the Engineer and the resulting void backfilled with granular material to the approval of the Engineer.
- 8 Any additional excavation below the bottom of the line required shall be made good with granular material.
- 9 The pipes shall be laid at the designated levels and gradients. The deviation in level from that designated at any point shall not exceed 20 mm unless agreed otherwise by the Engineer.
- 10 Pipes shall be laid so that each one is in contact with the bed throughout the length of its barrel.
- 11 Parts and fittings shall be examined for damage and shall be cleaned immediately before laying. Any pipes that are damaged shall not be used in the works.
- 12 Measures shall be taken to prevent soil or other material from entering pipes and to anchor each pipe to prevent moving before the work is complete.
- 13 The pipe bedding material shall be as designated on the project drawings or in the contract documents

17.3 EXTENDING PIPELINES

- 1 Where it is designated that existing drains are to be extended and connected to new drain chambers or channel, the connections shall be made during the construction of the new drain. The Contractor shall inform the Engineer in writing of the proposed position for the connection and the detail of the connection. The position of the connection shall be recorded by the Contractor on a drawing.
- 2 The new connecting pipe shall be aligned such that the angle between the existing pipe and the new pipe is not greater than 60 %.
- 3 Before entering or breaking into an existing drain, the Contractor shall obtain approval from the authority responsible for the pipeline.

17.4 ROAD GULLIES

- 1 The type, position, dimensions and clear openings of gullies will be as designated on the drawings or in the project specifications.
- 2 Gullies shall be constructed so that no part of the spout or trap has a cross sectional area less than 2/3 that of the outlet.
- 3 Precast concrete gullies shall comply with BS 5911 Part 2.
- 4 Cast iron and steel gully gratings shall be kerb type gullies complying with EN 124 unless otherwise shown on the Contract Drawings.
- 5 The upper surface of gully gratings shall be flat except where otherwise designated. Slots in gratings or between gratings and frames shall not be orientated parallel to the direction of traffic, except where the slots are less than 150 mm long or less than 20 mm wide.
- 6 The frames shall be bedded on a 1 to 3 cement sand mortar.
- 7 Backfilling to precast gullies shall be carried out to formation level with general fill. Where mechanical compaction is impractical, the backfill shall be concrete of the designated grade.
- 8 Gully connections shall be constructed of minimum 150mm diameter Unplasticised PVC (PVC-U) pipes in accordance with BS 4660 or ESVC pipes in accordance with EN 295. Where required by the Engineer, these shall be bedded and surrounded with concrete with movement at the joints permitted by the insertion of compressible material which shall extend to the outside of the concrete surround.

17.5 MANHOLE COVERS AND GULLY GRATINGS

- 1 Manhole covers and gully gratings shall be formed from ductile iron with an element of graphite spheres to produce a molecular structure that gives the required tensile strength and shock load resistance.
- 2 Drainage products may be produced from grey iron approved by Drainage Design Department as designated on the project drawings and shall be hard wearing, inherently stable and highly resistant to flexing.
- 3 The type of manhole cover; i.e., circular, square, rectangular, double triangular, single cover shall be as designated on the drawings.
- 4 During installation the frames shall be properly bedded and levelled to prevent rocking or any lateral movement of the frame.
- 5 Covers and frames shall be kept together as a supplied unit and interchangeability between various covers and frames shall not be permitted.
- 6 All castings shall be supplied with a black epoxy coating finish.
- 7 The tops of all manhole covers shall have a non-slip surface to provide adequate grip.
- 8 When so designated, the supplier shall arrange for specific lettering to be cast into the top of the covers. The lettering shall be up to a maximum of 4 letters or digits.
- 9 Manhole covers and gullies shall meet the requirements of EN 124, European Standard for access covers of gully tops for vehicular and pedestrian areas.
- 10 All manholes covers and gullies supplied shall have been verified as being manufactured to EN 124 by third party assessment body for both quality procedures and technical requirements.

- 11 The manholes' covers or gullies shall meet one of the loading categories specified in EN 124 as shown in table 17.1.

In Expressways, Highways and roads with two or more lanes with speed limit above 60 km/h, Extra Heavy Duty Covers will be required (E 600 in the EN 124 classification).

Table 17.1

Loading Categories for Manhole Covers on Gullies

Class	Loading, Tonnes
A 15	1.5
B 125	12.5
C 250	25
D 400	40
E 600	60

- 12 For a manhole entry to Foul Sewer, standard manhole and Surface Ground Water manhole, a circular clear opening of 675 mm diameter shall be provided, unless projects require wider opening due to operational issues and to be approved by design department on project basis. The frame must be suitable to install GRP sealing plate. For entry to TSE chambers, a minimum of 675mm square opening shall be provided.
- 13 For manholes situated in the carriageway, a three point cover seating shall be adopted to prevent any movement or rocking.
- 14 Where hinged gully gratings are installed the edge with a hinge shall face the traffic to ensure the cover closes if inadvertently left opened and hit by traffic.

17.6 SOAKAWAYS

- Soakaways shall be constructed using precast concrete rings. Concrete works shall comply with the requirements of Section 5 of the specification. Concrete shall be Grade C50 for the precast concrete rings and the cover slab, using Sulphate Resisting Portland Cement.
- The cover slab shall be of the dimensions and contain the reinforcement as shown on the drawings or detailed in the Project Specifications.
- The structural concrete shall be designed for durability and shall include as a minimum the following specification:
 - minimum cover 40mm
 - all surfaces to be painted with an epoxy protective coating meeting the requirements of Section 5 Part 14 of the specification. The protective coating shall be factory applied to precast elements.
- The soakaways shall have an internal diameter of 1.8 m unless otherwise designated and shall be of a minimum depth of 3 m unless otherwise designated.
- The precast concrete rings shall be at least 150 mm thick and shall have three evenly spaced lifting points.

- 6 No permanently embedded metal parts shall be left with a cover less than 40 mm from the surface. The precast rings shall be constructed with 50 mm diameter holes at 400 mm centres in rows spaced 300 mm apart. The holes shall be alternately offset.
- 7 The bottom ring shall be founded on insitu blinding concrete 200 mm deep.
- 8 The soakaway shall be surrounded by granular material which shall infill the whole void between the soakaway and the undisturbed ground around the excavation.
- 9 The granular material shall be laid in tamps in 150 mm layers and shall nowhere be less than 225 mm in width.
- 10 The granular material shall be clean durable, sharp-angled fragments roughly cubical or pyramidal in shape, of un-weathered rock of uniform quality graded and tested in accordance with Tables 17.3 and 17.4, from a source approved by the Engineer.
- 11 Cast iron covers and frames shall be to EN 124 of the designated loading class.
- 12 Geotextile material lining to the outside of the soakaway excavation shall be in accordance with Table 17.2 of this Section. The placing and laying of the material shall be in accordance with the manufacturer's instructions and Part 15 of this Section.
- 13 The geotextile material shall not be left exposed to the sun for a period greater than 7 days before burying.

17.7 SOAKAWAY BOREHOLES

- 1 The Contractor shall drill soakaway boreholes at the locations shown on the drawings. Unless designated otherwise the boreholes shall be 150mm diameter.
- 2 Boreholes shall be initially taken to a depth of 20 m. At this depth the borehole shall be thoroughly flushed clean using compressed air and clean water.
- 3 The borehole shall then be completely filled with clean water and the rate of dissipation recorded. If the rate of dissipation is found to be less than required by the design criteria given in BRE digest 365 - Soakaway Design then the bore holes shall be deepened in 5 m depth increments and flushed until a satisfactory rate of dissipation is recorded. At the Engineers discretion the rate of dissipation maybe verified by a constant head permeability test using proprietary equipment to monitor and record the flow rate and the variation in water level within the borehole.

17.8 TESTING AND CLEANING SURFACE WATER DRAINS

- 1 Before completing of the road drainage part of the Works the Contractor shall systematically clean the whole road drainage system, in accordance with Section 8, Part 10, including gullies, connecting pipes and soakaways. The entire system shall be clear of debris and silts and in a sound working order.
- 2 Cast iron covers shall be freed from surfacing materials and pivot points shall be greased. The Contractor shall be responsible for cleaning up any silting of the surface water drainage system caused by other Contractors working within the Site and the approval of the Employer.
- 3 A CCTV survey shall be carried out of the completed system in accordance with Section 8, Part 10 of QCS.

17.9 TRENCH SOAKAWAYS

17.9.1 General

- 1 Trench soakaways shall be constructed in accordance with the dimensions and grades shown on the Drawings. The trench soakaway consists of a perforated pipe or geocellular units laid in a trench. A geotextile fabric lines the trench or surrounds the geocellular units, with the remaining voids being filled with single sized coarse aggregate.
- 2 Reinstatement of trench soakaways shall be in accordance with the Contract drawings.

17.9.2 General

- 1 Excavation for the trench shall be in accordance to the requirements of Part 3 of this Section.

17.9.3 Pipe

- 1 The pipe shall be a 300mm UPVC for installations outside the carriageway and 300mm ESVC for installations within the carriageway, perforated pipe supported on single-size coarse aggregate bedding. Pipe perforations shall be 10mm diameter in staggered rows around the circumference of the pipe with a pitch of 40degrees. The longitudinal spacing between each row of holes shall be 200mm.
- 2 The manufacture, distribution, laying and jointing of perforated pipes shall generally be in accordance with the requirements of Section 8.

17.9.4 Geotextile Fabric

- 1 Filter fabric material lining shall be non-woven geotextile manufactured from UV stabilised, high tenacity, virgin polypropylene fibres that have been both mechanically and thermally bonded and in accordance with Table 17.2.
- 2 The placing and laying of the material shall be in accordance with the manufacturer's instructions and Part 15 of this specification.
- 3 The geotextile material shall not be left exposed to the sun for a period greater than 7 days before burying.

Table 17.2
Properties of Geotextile Material

Property	Test Method	Unit	Mean Value (Applied Tolerance ^(a))
Tensile Strength	ISO 10319	kN/m	Min 8.0 (-0.8)
Tensile Elongation	ISO 10319	%	60 (-20) Min. in both directions
CBR Puncture Resistance	ISO 12236	N	Min.
Cone Drop	ISO 13433	mm	38 (+6) Max.44
Pore Size – Mean AOS	ISO 12956	µm	75 (±20)
Permeability – (H ₅₀)	ISO 11058	l/m ² s	90 (-27) Min.63

Weathering 50MJ/m ² Exposure (1 month EU)	EN 12224	%	>90
Microbiological resistance	EN 12225	%	No loss
Resistance to acids & alkalis	EN 14030	%	No loss
Oxidation at 85 days (100 years)	EN 12226	%	>90
Thickness @ 2kPa	ISO 9863-1	mm	Min.1.

Note: (a) Applied tolerances are based on 95% Confidence limits

17.9.5 Single Sized Coarse Aggregate

- The trench shall be filled by granular material, which shall infill the whole width of the trench between the undisturbed ground trench sides, or between the geocellular units and the undisturbed ground, as shown on the drawings. The granular material shall be laid and tamped in 150 mm layers using mechanical plate compactors. For geocellular unit trenches the backfill shall be brought up in even layers such that the backfill material does not differ by more than 150mm in level between sides.
- Where geotextile fabric is required to interface between the trench side walls and subgrade and the soakaway trench fill material, the width of the geotextile must include sufficient material to conform to trench perimeter irregularities and for a 150mm top overlap. When overlaps are required between rolls, the uphill roll should lap a minimum of 500mm over the downhill roll in order to provide a shingled effect. Care shall be exercised to prevent natural or fill soil from intermixing with the trench granular material. All contaminated granular fill shall be removed and replaced with clean material.
- The granular material shall be clean, durable, sharp-angled fragments roughly cubical or pyramidal in shape, of un-weathered rock of uniform quality and meet the grading limits in Table 17.3. The materials source shall be approved by the Engineer based upon the properties of the materials in accordance with the testing requirements as per Table 17.4. No reactive carbonate rock or sources with indication of local ground water contamination shall be used.

Table 17.3
Grading Limits for Granular Material

BS sieve size (mm)	% passing by weight
37.5	100
20	60 - 90
14	5 - 30
10	2 - 10
5	0 - 2

Table 17.4
Grading Limits for Granular Material

Item No.	Requirement	Test Methods	Permissible limits
1	Grading	EN 933-1	Table 17.3

Item No.	Requirement	Test Methods	Permissible limits
2	Clay lumps and friable particles	ASTM C142	1% max
3	Lightweight pieces	ASTM C123	0.5% max
4	Water absorption (SSD)	ASTM C128/127	2.0% max
5	Shell content	EN 933-7	3% max
6	Soundness (5 cycles by $MgSO_4$)	ASTM C88	15% max
7	Loss by Los Angeles abrasion	ASTM C131/C535	30% max

17.9.6 Catchpit Chambers

- Catchpit chambers shall be constructed to the dimensions and at the spacing shown on the drawings.
- Chambers shall consist of rectangular precast concrete sections with internal dimension 800 x 1500mm. All concrete works shall comply with the requirements of Section 5 of the specification. Concrete shall be Grade C50. Sulphate Resisting Cement shall be used. Chambers shall also conform in all respects to the requirements for surface water drainage manholes in Section 8.
- All surfaces to be painted with an epoxy protective coating meeting the requirements of Section 5 Part 14 of the specification. The protective coating shall be factory applied to precast elements.

17.9.7 Road Crossings

- Where the trench soakaway crosses a road then non-perforated pipe shall be used extending 1.0 meters beyond the road kerb line.

17.9.8 Geocellular Stormwater Attenuation / Soakaway Trenches

- Loads on modular geocellular unitsThe permanent vertical loads to be carried by the units shall be determined by the designer
 - Lateral loads
 - Maximum installation depth

17.9.9 The maximum installation depth, to base of units, shall normally not exceed the height of Reinstatement above Trenches

- Reinstatement material above the trenches shall be of suitable fill, cement bound granular material, foamed concrete pavement materials or asphalt, or as appropriate in accordance with the Contract drawings, and shall be constructed in accordance with QCS Section 6.

17.9.10 Testing

- On completion of each length of trench soakaway the Contractor shall carry out an infiltration test. The test shall be carried between completed catchpit chambers. The 2 No. upstream outlet pipes within the catchpit chamber shall be sealed and the chamber filled with water to a minimum depth of 1.5 metres. The depth of water shall be recorded each hour for the first twelve hours of the test and subsequently at time intervals as directed by the Engineer.

- 2 The Contractor shall record the results of the test on a standard proforma and present these to the Engineer on completion.

17.10 GEOCELLULAR TANKS

17.10.1 Geocellular Units

- 1 Geocellular units used to form storm water attenuation tanks and soakaway tanks shall be in accordance with clause 17.9.8.

17.10.2 Geocellular Tank Arrangement

- 1 Locations for geocellular tanks

Geocellular tanks made up of geocellular units are suitable for installation in the following locations:

- Public open spaces: beneath landscaped areas and paths. The landscaping scheme for the park shall be considered when assessing the loads upon the tank.
- The vehicular access to the tank shall be restricted so as to exclude large vehicles, in excess of the design vehicle load, from the area above the tank.

- 2 Loads on modular geocellular units

The design of tanks constructed using modular geocellular units shall:-

- take account of all applied loads, including accidental loading
- be based on appropriate laboratory tests
- use appropriate factors of safety
- analyse all appropriate limit states (or failure modes)

The determination of the loads to be carried by the geocellular units shall be determined in accordance with the requirements of BD 31/01.

- 3 Permanent loads.

- 4 Accidental loads

The risk of accidental loading occurring shall be assessed in the design process. Public parks may be occasionally inadvertently trafficked by HGVs and landscaped area can be used to park cars. Hard paved area shall be assumed liable to support such occasional accidental loading and geocellular tanks shall be designed to support accidental loading without risk of collapse.

Location	Risk
Landscaped area in public park	Specialist vehicles used for maintenance of geocellular tank and any separation system upstream of the tank
	Illegal parking of private vehicles
	Movement of delivery vehicles to kiosks in parks
	Large vehicles used for routine maintenance within park
	Specialist vehicles used for erection / maintenance of lighting systems
	Erection of marquees / tents / stages / portable cabins for public events
	Large vehicles delivering equipment for public events

Location	Risk
	Cranes for installation of equipment
	Generators used for public events
	Planned parking of private vehicles during public events
	Access for emergency vehicles – fire engines

If the tank has not been designed to carry accidental loading then special precautions may be required to prevent it occurring. In public parks, the area above a tank shall be fenced off or have other barriers / landscaping to prevent vehicle access. Warning signs shall be provided to state that there is an area with limited load bearing capacity and restricted access for vehicles.

The location of the tank and any loading restrictions shall be clearly identified in the operation and maintenance manual for any facility.

5 Lateral loads

The lateral loads on the units due to earth and water pressure shall be assessed and allowed for by the designer in accordance with the requirements for the design of retaining walls given in BS 8002:1994.

6 Flotation or uplift

Where the tank system is located below the water table, the uplift force shall be resisted by the dead weight of fill above the tank. Other surcharges that are not permanent shall not be included in the assessment.

The minimum factor of safety against flotation shall be 1.25.

7 Minimum cover

The minimum cover to units shall be as follows:

Landscaped areas: a minimum of 1.0m to allow for suitable planting over the tank.

The design of landscaping should be undertaken at the same time as the design of the tank so that the impact of tree roots can be considered. Trees should not be located closer than the canopy width at mature height from the tank. Trees should not be planted directly over a tank or in such a position where maintenance work would require the removal of the tree.

8 Maximum installation depth

The maximum installation depth, to base of units, shall normally not exceed the height of three units, plus the cover as assessed in Sub-Clause 15.

9 Limit state design

Modular geocellular tanks shall be designed as structural components, using limit state structural design theory in accordance with Section 4.1 of CIRIA Report C680 and BD 31/01. The design philosophy shall follow the requirements for geotechnical design practice as described in Eurocode 7 (EN 1997-1).

END OF PART