# RIBA 4 Civil Engineering Specification

Defence Infrastructure Organisation
RIBA 4

ProjectReference: CITSO Kenya
Project number: 60707392
CITSO-ACM-XX-XX-SP-CE-00001

June 2024

## Quality information

| Prepared by | Checked by | Verified by | Approved by |
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## Revision History

| Revision | Revision date | Details | Authorized | Name | Position |
|---|---|---|---|---|---|
| P01 | 19/06/2024 | Initial | GR | George Rossi | Project Manager |
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# 1. Introduction

The works shall generally be undertaken in accordance with the specifications below. Where no specification is referenced for a section of works to be delivered under this contract that section of the works shall comply with the appropriate current Kenyan, British or European standards and provide an acceptable operational performance.

This document covers the Civil Engineering Specification. For Architectural, Structural (excluding below ground tanks) and MEP details, refer to the relevant specification document.

Where ambiguities or uncertainties arise, the Contractor shall raise a RFI or TQ to the *Project Manager* or *Supervisor* prior to commencement of the works in question.

## 1.1 Brief Description of the Works

The Kenya Counter Insurgency Terrorism and Stability Operations (CITSO) Project is to deliver 2 Nr new facilities on the existing CITSO training base. The CITSO site is a trilateral venture between the Kenyan Defence Force (KDF, United Kingdom Ministry of Defence (MoD) and United States Department of Defence (DoD);

The buildings are single storey of masonry and concrete construction with a pitched roof covered with a jungle green clay tile. The headquarters building includes the provision of a reception facility, office space, conference facilities and associated building support (such as parking areas, footpaths, and landscaping). The medical centre includes the provision of a reception facility, examination rooms, laboratory, male & female observation rooms and a triage/procedures room and associated building support (such as parking areas, footpaths, and landscaping).

## 1.2 Existing Site Conditions

The site is located on the south-eastern outskirts of Nanyuki, a town located at the foothills of Mt. Kenya which is approximately 150 km (90 miles) north of Nairobi. The proposed headquarters and medical facility sites currently comprise a conifer plantation managed by the Kenyan Forestry Service (KFS) divided by several tracks at the northern end of the site. KDF already hold special use licences (NEMA and EIA) from KFS to undertake this work, with an agreement in principle to only clear the areas needed for construction and site access. The *Contractor* must comply with all conditions attached to the special use licences.

The main access point for the site is a dirt road located southeast of the proposed headquarters. Construction work on some CITSO buildings has been completed.

The central portion of the site extending from the western boundary to southeast is partially vegetated grassland with isolated clumps of trees, showing some signs of erosion such as wash outs, rills, and gullies. Significant portions of the site in the north, eastern and southwestern extents comprise of conifer plantations.

Refer to the project Geotechnical Interpretive Report (GIR) and Geotechnical Design Report (GDR) for details of existing ground conditions. The Contractor shall fully consider the contents of these reports when assessing methodology, risk, cost and programme.

## 1.3 Pre-Construction Information

Refer to the MPP Preconstruction Information document for further details including site details, access constraints, health & safety, welfare requirements, emergency procedures and hazards.

The requirements set out in this document form part of the project Scope.

# 2. List of references

## 2.1 Kenyan and East African Standards

| | |
|---|---|
| KS EAS 131-1:2008 | Concrete – Part 1: Specification, performance, production and conformity. |
| EAS 18-1 | Cement – Part 1: Composition, specification and conformity criteria for common cements. |
| KS 548:1985 | Precast concrete pipes and fittings for drainage, sewerage and culverts — Specification |
| | Ministry of Transport and Communications – Standard Specification for Road and Bridge Construction (1986) |

## 2.2 British and European Standards

| | |
|---|---|
| EN 934-2 | Admixtures for concrete, mortar and grout. Concrete admixtures. Definitions, requirement, conformity, marking and labelling. |
| EN 12620:2000 | Aggregates for concrete. |
| EN 1097-6 | Tests for mechanical and physical properties of aggregates. Determination of particle density and water absorption. |
| BS 8666 | Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. |
| BS 7973-2 | Spacers and chairs for steel reinforcement and their specification. Fixing and application of spacers and chairs and tying of reinforcement. |
| EN 622-1:2003 | Fibreboards. Specifications. General Requirements. |
| EN 622-4:2024 | Fibreboards. Specifications. Requirements for softboards |
| BS 6398:1983 | Specification for bitumen damp-proof courses for masonry |
| BS 8204-2 | Screeds, bases and in situ floorings. Concrete wearing surfaces. |
| BS 4551 | Mortar. Methods of test for mortar and screed. Chemical analysis and physical testing. |
| EN 1504-10 | Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Site application of products and systems and quality control of the works. |
| EN 13139 | Aggregates for mortar. |
| EN 622-1 | Fibreboards. Specifications. General requirements. |
| EN 622-4 | Fibreboards. Specifications. Requirements for softboards. |
| BS 6398 | Specification for bitumen damp-proof courses for masonry. |
| EN 13877-3 | Concrete pavements. Specifications for dowels to be used in concrete pavements. |
| BS 4660 | Thermoplastics ancillary fittings of normal sizes 110 and 160 for belowground gravity drainage and sewerage. |

| | |
|---|---|
| EN 1401-1 | Plastics piping systems for non-pressure underground drainage and sewerage. Unplasticized poly(vinyl chloride) (PVC-U. Specifications for pipes, fittings and the system. |
| EN 61386-24 | Conduit systems for cable management. Particular requirements. Conduit systems buried underground. |
| BS 4449 | Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification. |
| BS 4482 | Steel wire for the reinforcement of concrete of concrete products. Specification. |
| BS 4483 | Steel fabric for the reinforcement of concrete. Specification. |
| BS 410-1 | Test sieves. Technical requirements and testing. Test sieves of metal wire cloth. |
| BS 410-2 | Test sieves. Technical requirements and testing. Test sieves of perforated metal plate. |
| BS 812-124 | Testing aggregates. Method for determination of frost heave. |
| BSI PAS 128 | Specification for underground utility detection, verification and location |
| BS 812-124 | Testing aggregates. Methods for determination of frost heave. |
| BS EN 933-1 | Tests for geometrical properties of aggregate. Determination of particle size distribution. Sieving method. |
| BS 1377-2 | Methods of test for soils for civil engineering purposes. Classification tests and determination of geotechnical properties. |
| BS 812-111 | Testing aggregates. Methods for determination of ten per cent fines values (TFV). |
| BS 5835-1 | Recommendations for testing of aggregates. |
| BS EN 1295 | Structural design of buried pipelines under various conditions of loading - General requirements |
| BS EN 12201 | Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE) - General |
| BS EN 805 | Water supply - requirements for systems and components outside buildings |
| BS EN 545 | Ductile iron pipes, fittings, accessories and their joints for water pipelines. |
| BS 1247-1 | Manhole steps. Specification for plastics encapsulated manhole steps. |
| BS 5041-1 | Fire hydrant systems equipment. Specification for landing valves for wet risers. |
| EN 124 | Gully tops and manhole tops for vehicular and pedestrian areas. |
| BS 7263-1 | Precast concrete flags, kerbs, channels, edgings and quadrants. Prescast, unreinforced concrete paving flags and complementary fittings. Requirements and test methods. |
| BS 7263-3 | Precast concrete flags, kerbs, channels, edgings and quadrants. Prescast, unreinforced concrete kerbs, channels, edgings and quadrants. Requirements and test methods. |

## 2.3 Other Standards

HSG 47 Avoiding danger from underground services

Model contract document for sewer condition inspection. 2nd edition

Water Industry Specification (WIS) Specification of bedding and sidefill materials WIS 4-08-02

Water Industry Specification (WIS) Specification for the fusion jointing of polyethylene pressure pipeline systems using pe80 and pe100 materials WIS 4-32-08

Guide to pressure testing of pressure pipes and fittings for use by public water suppliers IGN 4-01-03

Specification for Mechanical Fittings and Joints Including Flanges for PE Pipes for the Conveyance of Cold Potable Water WIS 4-24-01

# 3. List of Drawings

## 3.1

### Table 1. RIBA 4 Civils Drawings

| Drawing No. | Drawing Title | Revision |
|---|---|---|
| CITSO-ACM-XX-XX-DR-CE-00001 | OVERALL SITE LOCATION PLAN | P01 |
| CITSO-ACM-XX-XX-DR-CE-00002 | FOUL DRAINAGE TYPICAL DETAILS | P01 |
| CITSO-ACM-XX-XX-DR-CE-00004 | STORMWATER TYPICAL DETAILS | P01 |
| CITSO-ACM-XX-XX-DR-CE-00005 | ROAD AND FOOTPATH DETAILS | P01 |
| CITSO-ACM-XX-XX-DR-CE-00007 | SITEWIDE CULVERT AND SWALE DETAILS | P01 |
| | | |
| CITSO-ACM-04-XX-DR-CE-00001 | HQ – LAYOUT PLAN | P01 |
| CITSO-ACM-04-XX-DR-CE-00002 | HQ - EARTHWORKS | P01 |
| CITSO-ACM-04-XX-DR-CE-00004 | HQ - LAYOUT SECTIONS SHEET 1 OF 2 | P01 |
| CITSO-ACM-04-XX-DR-CE-00005 | HQ - LAYOUT SECTIONS SHEET 2 OF 2 | P01 |
| CITSO-ACM-04-XX-DR-CE-00010 | HQ - SETTING OUT POINT LIST | P01 |
| CITSO-ACM-04-XX-DR-CE-00020 | HQ – DRAINAGE LAYOUT PLAN | P01 |
| CITSO-ACM-04-XX-DR-CE-00021 | HQ –RWH & FIRE TANK GENERAL ARRANGEMENT | P01 |
| CITSO-ACM-04-XX-DR-CE-00050 | HQ – SEPTIC TANK GENERAL ARRANGEMENT | P01 |
| CITSO-ACM-04-XX-DR-CE-00100 | HQ – KERB LAYOUT | P01 |
| CITSO-ACM-04-XX-DR-CE-00101 | HQ – ROAD LONG SECTIONS | P01 |
| | | |
| CITSO-ACM-09-XX-DR-CE-00001 | MC – LAYOUT PLAN | P01 |
| CITSO-ACM-09-XX-DR-CE-00002 | MC - EARTHWORKS | P01 |
| CITSO-ACM-09-XX-DR-CE-00004 | MC - LAYOUT SECTIONS SHEET 1 OF 2 | P01 |
| CITSO-ACM-09-XX-DR-CE-00005 | MC - LAYOUT SECTIONS SHEET 2 OF 2 | P01 |
| CITSO-ACM-09-XX-DR-CE-00010 | MC - SETTING OUT POINT LIST | P01 |
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| CITSO-ACM-09-XX-DR-CE-00100 | MC – KERB LAYOUT | P01 |
| CITSO-ACM-09-XX-DR-CE-00101 | MC – ROAD LONG SECTIONS | P01 |
| CITSO-ACM-09-XX-DR-CE-00102 | MC – AMBULANCE DROP-OFF AREA DETAILS | P01 |

# 4. General

## 4.1 Site Accommodation and Facilities

1. Site compound as shown on CITSO-ACM-04-XX-DR-CE-00002.
2. During the construction period the *Contractor* provides adequate welfare facilities for all operatives and staff, including sub-*Contractor*s. These include drying rooms, mess rooms with facilities for heating food and making hot drinks along with toilet facilities.
3. The *Contractor* is responsible for the daily cleaning and maintenance of provided facilities.
4. On completion of the works, the *Contractor* shall regrade the site accommodation area and finish with topsoil and grass seed unless otherwise agreed with the KDF and *Project Manager.*

## 4.2 External Stakeholders and Agreements

1. The *Contractor* provides copies of all agreements reached with others to the *Project Manager*.

## 4.3 Health & Safety

1. Refer to Pre-Construction Information and Construction Safety Document.
2. Site specific hazards and generic site risks are noted on the Enabling Works drawings and CITSO Kenya SiD Workbook.

## 4.4 Site Cleanliness and Use of Land

1. The *Contractor* shall take all necessary steps to avoid creating a dust nuisance. If, in the opinion of the *Project Manager*, the *Contractor* is not dealing adequately with the control of dust, the *Project Manager* may instruct the *Contractor* to carry out such additional measures as the *Project Manager* considers are necessary, at the *Contractor*'s expense.
2. The *Contractor* shall keep all roads, private entrances, verges, paths, footways, drains and ditches that are affected by the works or by vehicles of the *Contractor* or by any of their sub-*Contractor*s or by suppliers of materials or by plant free from mud, slurry or other hazardous substance that is deposited through his operations and in a safe, clean and passable state. All waste or superfluous material or any substance deposited by the *Contractor* or their sub-*Contractor* shall be promptly removed by the *Contractor* at their expense.
3. The *Contractor* shall obtain the approval of the KDF as to siting of all huts, equipment, stacks or heaps within the site. On completion of the Contract, the huts, equipment, etc. shall be removed and the site made good to the satisfaction of the *Client*.
4. The *Contractor* shall take all necessary precautions to prevent danger, nuisance or inconvenience to the owners, tenants or occupiers of adjacent properties and to the public generally. The *Contractor* shall make their own arrangements with the owners, tenants and occupiers concerned for the use of any private land for plant, stores, working space, borrow pits or spoil dumps they require and they shall be deemed to have included in their rates for so doing.

## 4.5 Setting Out and Existing Ground Levels

1. All levels provided at road tie-ins must be regarded as approximate and may require to be adjusted at site to suit the existing road levels and topography. Tenderers shall allow for adjustment of levels at road tie-ins to suit existing levels. Such adjustments shall not compromise road gradients or drainage.
2. Before commencement of any earthworks, the *Contractor* shall establish permanent survey stations within the Site sufficient for the setting out and checking of the Works.

## 4.6 Existing Utilities

1. Existing utilities, where known, are indicated on the drawings. Refer to Enabling Works package and specification for details of required surveys and diversions.

2. The *Contractor* shall satisfy themselves that all utilities present on site have been identified prior to commencement of ground intrusive works.
3. Refer to CITSO-ACM-09-XX-DR-BS-991001 and CITSO-ACM-04-XX-DR-BS-491001 within MEP Drawings for combined proposed services layout.

## 4.7 References to The Engineer

1. Where references are made to 'The Engineer' in referenced or associated specifications, this shall be taken to mean the *Supervisor* for matters relating to quality and the *Project Manager* for all other matters.

## 4.8 Materials Approval Requests

1. All products, materials and required method statements shall be submitted via the agreed Material Approval Request (MAR) process to the *Supervisor* or *Project Manager* for acceptance. These shall contain any written documentation that supports the product or material in meeting the Specification outlined in the Scope.
2. Where equivalent alternatives to the Scope are proposed, the differences shall be clearly outlined in the MAR.
3. The Contractor shall account for the *period of reply* for MAR responses in their programme.

# 5. Drainage

## 5.1 Pipework

1. Pipes are to be laid straight with no bends.
2. All pipes at to be laid in straight lines with level soffits unless noted otherwise.
3. The *Contractor* shall give due consideration to the protection of pipes from construction traffic loading during construction.
4. Pipework to be installed to manufacturer's instructions.

## 5.2 Foul and Roof Drainage Pipework

1. Pipes to be uPVC to KS-ISO3633, KS-ISO 1452, BS 4660 or BS 5841, or BS EN 1401 or equivalent approved standard.
2. Twinwall HDPE or thermoplastic pipework may be used subject to acceptance by the *Project Manager.*
3. Laying, jointing and testing of pipework shall be to BS 5955 and manufacturer's requirements. Joints shall employ a flexible rubber ring which shall meet the requirements of BS 2494.
4. Pipes to have a minimum stiffness of SN4.

## 5.3 Culvert Pipework

1. All culvert pipe to be strength Class H DN450 concrete pipe complying with the relevant provisions of KS 548:1985.

## 5.4 Excavation for Pipes and Chambers

1. Excavation shall comply with Section 11.

2. Soft spots existing below the bottom of an excavation shall be removed and the resulting voids backfilled with Type 1 unbound mixture for subbase or pipe bedding material both well compacted, or C16/20 concrete. Refer to Section 9.4 for Type 1 mixture requirements.

3. Any additional excavation below the bottom of an excavation that is required because the *Contractor* has allowed the bottom to become soft or otherwise unacceptable for the construction of the pipeline or chambers shall be made good. Any excavation greater than the net volume required for the permanent works below the level of any pipe surround shall be made good.

4. All pipes in or under new embankments shall be laid only when the embankment has been formed and compacted to formation level under paved areas, to finished earthworks level in other areas, or to a level which will give a minimum cover of 0.9m to the pipes, whichever is the lowest.

## 5.5 Pipelaying Generally

1. Where socketed pipes are required to be laid on a granular or sand bed, or directly on a trench bottom, joint holes shall be formed in the bedding material or excavated formation to ensure that each pipe is uniformly supported throughout the length of its barrel and to enable the joint to be made.
2. Where pipes are required to be bedded directly on the trench bottom, the formation shall be trimmed and levelled to provide even bedding of the pipeline and shall be free from all extraneous matter that may damage the pipe, pipe coating or sleeving.

3. Any protective cap, disk or other appliance on the end of a pipe or fitting shall only be removed permanently when the pipe or fitting which it protects is about to be jointed. Any exposed pipe ends shall be capped when pipelaying is not actively being carried out to prevent vermin or soil entering the pipework.
4. Pipes and fittings, including any lining or sheathing, shall be examined for damage and the joint surfaces and components shall be cleaned immediately before laying. Where repairs are required, these shall be agreed with the *Client*.
5. Suitable measures shall be taken to prevent extraneous material from entering the pipe, and to anchor each pipe to prevent flotation or other movement before the Works are complete.
6. Where the gradient of the as-laid pipeline exceeds 5%, installation shall be uphill with sockets leading.
7. The *Contractor* is responsible for ensuring the protection of all buried pipework from construction vehicle loading.

## 5.6 Pipe Bedding

1. Pipe bedding to be in accordance with BS EN 1295-1 and Water Industry Specification WIS 4-08-02 including material size and type.
2. Bedding for pipes shall be constructed by spreading and compacting granular bedding material over the full width of the pipe trench in layers not exceeding 150 mm before compaction, to a finished thickness of between 100 mm to 300 mm above the crown of the pipes.
3. After the pipes have been laid, additional material shall, if required, be placed and compacted equally on each side of the pipes and, where practicable, this shall be done in sequence with the removal of the trench supports.
4. Where trenching excavators or similar narrow trenching techniques are employed for open dig laying of pipelines, the minimum gap between the pipe barrel and side of the trench shall be 30 mm for pipe diameters of 280 mm or less, and 50 mm for pipes greater than 280 mm diameter.
5. In bad ground conditions where the migration of the pipe granular surround into the ground may occur, the surround shall be wrapped in geotextile membrane.
6. Pipes to be bedded on concrete shall be supported on precast concrete setting blocks, the top face of each block being covered with two layers of compressible packing.
7. Concrete protection shall be interrupted over its full cross-section at each pipe joint by a shaped compressible filler.
8. Compressible filler for interrupting concrete protection to pipelines shall consist of bitumen-impregnated insulating board to BS EN 622-1 and BS EN 622-4 or equivalent approved. The minimum thickness of compressible filler shall be 36mm.
9. Compressible packing for use between pipes and precast concrete setting blocks shall consist of bitumen damp-proof sheeting, complying with BS 6398 or equivalent. Bituminous materials shall not be put into contact with plastics pipes.

## 5.7 Chambers

1. 600mm long rocker pipes or alternative flexible joints are to be installed at entry and exit to all chambers and other structures. Both joints of the rocker pipes shall be flexible and not cast into the chambers or other structures.
2. Manholes and chambers shall be substantially watertight, with no discernible flow of water penetrating the works.
3. The base of the chamber is to be provided with a high strength granolithic wearing screed to comply with abrasion resistance to class AR4/WS of Table 4 of BS 8204-2 and formed with four parts 8mm dust to one part sulphate resisting cement placed with a steel trowel finish. Where sulphate resisting cement is unavailable, then a combination of Portland Cement (CEM 1) and GGBS FS or PFA shall be used to give equivalent resistance to sulphate attacks.

## 5.8 Frames & Covers

1. Manhole covers and frames shall be in accordance with the requirements of BS EN 124 and rated D400 unless otherwise noted or agreed.

2. Chamber frames shall be set to level or to suit proposed ground levels as required, bedded and haunched externally over the base and sides of the frame in mortar, in accordance with the manufacturer's instructions.

## 5.9 Testing & Inspections

1. Refer to Section 13.4 for testing requirements.
2. The line and level of all pipework and chambers is to be accepted by the *Supervisor* prior to backfilling.

## 5.10 Filter Drains

1. Filter drains to be uPVC or HDPE to BS 4660 or BS5481 or BS EN 1401 with a minimum stiffness of SN4.
2. Filter drains to be bedded and surrounded with uniformly graded rounded granular clean stone 20-60mm diameter with a minimum void ratio of 30%.
3. Filter material to be surrounded on all sides with permeable geotextile filter material.
4. Filter drain pipework shall be perforated with not less than 1000mm$^2$ of holes per metre length of pipe. The perforations shall not reduce the pipe ring stiffness by more than 5%. Circular perforations not greater than 10mm nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6mm in width.
5. No airtight testing is required for perforated pipework.
6. A small diameter (50-100mm) solid wall pipe of minimum length 2m shall be laid at the base of the filter drain where it connects to the downstream chamber to prevent ponding in the base of the pipe surround.

## 5.11 Drain Field Trenches

1. Infiltration trenches, where noted on drawings, are to be constructed against undisturbed earth. Exposure of excavated surfaces shall be kept to a minimum to maintain the soil's permeability.
2. Gravel fill shall have a minimum permeability of $10^{-3}$ m/s.
3. Filter material to be surrounded on all sides with permeable geotextile filter material.
4. Drain field pipework shall be perforated with not less than 1000mm$^2$ of holes per metre length of pipe. The perforations shall not reduce the pipe ring stiffness by more than 5%. Circular perforations not greater than 10mm nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6mm in width.
5. Adjacent trenches are to be connected in series by solid wall pipework laid in Class S bedding, connected at each end into the trenches by a solid wall 90-degree bend.

## 5.12 Geotextile Filter Material

1. Geotextile filter material if required shall satisfy the rules for filter design set out in BS EN 1997-1:2004. The geotextile filter material shall be non-woven mechanically needled fabric composed of polypropylene or polyester filaments and shall have a minimum design life of 60 years.
2. Geotextile filter material shall be lapped (500 minimum) so that the upstream sheet lies on top of the downstream sheet.
3. Geotextile filter material wherever it be used shall, when tested in accordance with the requirements below, meet the minimum performance criteria described as follows:

| Criterion | Testing Standard | Requirement |
|---|---|---|
| Tensile Strength | BS EN ISO 10319 | 10 kN/m |
| CBR Puncture Resistance | BS EN ISO 12236 | 1500 N |
| Thickness at 2kPa | BS EN ISO 9863-1 | 1.0 mm |
| Permeability ($H_{50}$) | BS EN ISO 11058 | 100 m/s.$10^{-3}$ |

4. Prior to installation, conformance testing shall be arranged by the *Contractor*. The results shall be submitted to the *Project Manager*, together with the batch or consignment numbers to which they relate. Materials not conforming shall be rejected and replaced with material that has passed conformance testing.
5. Prior to delivery to site, the *Contractor* shall provide a storage area for the geotextile. The agreed area is to be prepared strictly in accordance with manufacturer's recommendations regarding the delivery and storage prior to the delivery of any material. The *Contractor* shall ensure that the handling equipment used does not damage the geotextile and that the rolls of geotextile are stored in such a manner that no damage occurs. The *Contractor* shall provide adequate and acceptable measures for protecting the material at all stages of the work from all sources of potential damage, such as sharp objects, boulders and cobbles, including weather conditions, until completion of the Contract.
6. The layer of material on to which the geotextile is to be placed shall not have protrusions or sharp projections, which are likely to damage the geotextile during installation or in service. The method of installation shall ensure that the geotextile is in continuous contact with the surface on which it is to be placed and the geotextile shall not be stretched or bridged over hollows or lumps. Operation of construction plant directly on the installed geotextile shall not be permitted.

## 5.13 Swales & Ditches

1. Swales shall be constructed with a minimum base width of 0.5m and 1:3 side slopes.
2. Swale subgrade to be left sufficiently permeable to allow water to drain easily. Sides and base to be constructed with 150mm topsoil with underlying, sand based subbase if required.
3. Swale bases shall be seeded with appropriate planting suitable for wet environments that allows conveyance of flows. This shall be done soon after excavation to allow time for the planting to grow.
4. Where alterations to the KDF spine roadside ditches are required as part of the works, the details of these shall be co-ordinated with the KDF and *Supervisor.*

## 5.14 Scour Protection

1. Scour protection required at the inlets and outlets of all culverts and at the junctions of all swales on the bank opposite the connecting swale.
2. Scour protection to be provided by stacking 150mm diameter uniformly graded clean angular rock in a layer minimum 300mm thick. Rocks to be clean, hard, dense, and durable rock free from cracks, seams, or other imperfections.
3. The top level of rock protection is to finish flush with the base and side slope of the ditches.
4. Stone pitching required along the base of the channel at the inlet and outlet of all culverts. Stone pitching to be formed of 150mm diameter uniformly graded clean angular rock half embedded in to concrete. Top surface of concrete to be level with ditch base. The stone shall be hand placed with closed joints into freshly spread mass concrete.

## 5.15 Tolerances and Inspections

1. The line and level of any pipeline shall not deviate from that described within the Contract by more than 20mm and any combination of such deviations shall not create a reverse gradient nor result in a clash with other proposed pipes, utilities or structures.

2. All pipelines and chambers are to be inspected and signed-off by the *Supervisor* prior to backfilling or installation of concrete surround.

3. Cover levels shown in drainage schedules are indicative and to be confirmed and agreed on site to suit proposed finished ground levels. The *Contractor* shall allow reasonable tolerance when constructing chambers to allow for alterations in final cover level.

# 6. Underground Tanks

## 6.1 Materials

1. Unless stated otherwise on contract drawings, underground tanks shall be in-situ reinforced concrete of grade C30/37 conforming to the Mix 1 specification in section 12.1 of this document.
2. Buried tanks shall have a 75mm thick blinding concrete layer. Blinding concrete shall be grade C16/20 conforming to the Mix 2 specification in section 12.1 of this document.
3. All concrete shall conform to the requirements detailed in section 12 of this document.
4. Surface finishes for different elements shall be as stated below in accordance with section **Error! Reference source not found.**:
    a. Tank walls – fair worked
    b. Base slab – steel trowel
    c. All other elements – fair finish

## 6.2 Construction

1. Buried tank cover slabs are to be cast on site separately and lifted into place. The exact lifting anchors and lifting strategy are to be proposed by the *Contractor* and agreed with the *Supervisor* prior to construction.
2. No materials should be stored on the roof of buried tanks. In water retaining structures PVC waterstops not less than 130 mm wide manufactured by an approved manufacturer shall be built into all construction joints in external walls and construction joints in roofs of water retaining structures. Construction joints shall be formed at positions specified on the contract drawings.
3. The *Contractor* shall be solely responsible for the watertightness of structures and remedial measures necessary.
4. Hydrophilic rubber sealer:
    a. Hydrophilic rubber sealer shall be co-extruded from chloroprene and hydrophilic rubbers into a cellular strip approximately 25 mm x 7 mm thick which expands as it absorbs water. The strip shall incorporate an expansion delay coating to prevent activation during setting of the surrounding concrete.
    b. Hydrophilic rubber sealer shall be applied to the perimeter of all pipes to be cast into water retaining concrete structures.
5. Built-in items:
    a. Where pipes, sleeves, water bars or other items are designed to be cast into concrete, they shall be constructed and installed in order to ensure that they are:
        - securely and rigidly retained in position;
        - watertight for the design life of the fittings and structure;
        - resistant to corrosion for the design life;
        - adequately bonded to the concrete; and
        - free from external coatings that may reduce the bond.
    b. Precautions shall be taken to prevent the formation of air pockets, voids or other defects whilst the concrete is being placed.

## 6.3 Fittings

1. Step irons:
    a. Where the depth of the invert exceeds 1 metre below the finished ground level. The step irons shall be post-installed in drilled holes and fixed using epoxy resin, in with alternate steps in line vertically and with such additional hand irons as the *Supervisor* may direct. Step irons must be set into the walls when these are built and not subsequently.
    b. Step-irons of general-purpose type shall comply in all respects with BS 1247-2.
2. Pumps:

a. The rainwater harvesting tanks shall have an adjacent dry-well with pump for circulating grey-water back to the buildings for reuse. For pump details refer to MEP documents and specifications.

b. Pumps shall be bolted to a 100mm high concrete plinth. The inlet pipe to the pump shall be set with its centreline 150mm above the base of the RWH tank.

3. Hydrants:

a. All fire tanks shall be provided with an above ground hydrant.

b. Hydrants shall comply with the requirements of BS 5041-1.

c. Appropriate signage markers shall be installed to identify the hydrants.

## 6.4 Excavation & Backfill

1. In general, excavations for and backfilling to tanks shall be carried out in accordance with Section 11 of this document.
2. Backfilling shall be carried out such that the level of backfill is equal on all sides of the tank to avoid even loading or damage.
3. Prior to backfilling, watertightness testing shall be carried out in accordance with 13.2 & 13.3 of this document.
4. Filling material shall be deposited in layers not exceeding 225mm unconsolidated thickness, and then full compacted to form a stable backfill.
5. Tanks shall be backfilled with selected fill material meeting the requirements stated in Section 11.13 of this document.

## 6.5 Access Covers

1. Manhole covers and frames shall be in accordance with the requirements of EN 124 and rated D400 unless otherwise noted or agreed.

2. Chamber frames shall be set to level or to suit proposed ground levels as required, bedded and haunched externally over the base and sides of the frame in mortar, in accordance with the manufacturer's instructions.

## 6.6 Testing & Inspections

1. Refer to the following sections for testing requirements:

a. Concrete – Section 12

b. Filling materials – Section 11

c. All other testing requirements - Section 13

# 7. Roads

## 7.1 Materials

1. Gravel roads shall comprise of the following:
    a. Gravel wearing course which shall be Class 2 in accordance with Table 12-2 of the Road Design Material: Part 3. Compacted in 150mm thick layers to 98% MDD (Modified AASHTO).
    b. Compacted lateritic gravel subbase. This shall be compacted in 150mm layers and meet the requirements of Clause 6.1.1.1.1 of the Road Design Manual: Part 3.
    c. Refer to contract drawing CITSO-ACM-XX-DR-CE-00005 for thickness details.
2. The concrete road for the Medical Centre ambulance area shall comprise the following:
    a. Reinforced concrete slab: to be grade C30/37 conforming to the Mix 1 specification in Section 12.1 of this document.
    b. 1000 gauge polythene sheet, obtained from an approved manufacturer, studded on the surface of the mass concrete. The concrete surface to which the slip membrane is to be fixed shall be finished with a steel float to provide a smooth true surface free from dust and loose particles.
    c. Underlying mass concrete slab: to be grade C16/20 conforming to the Mix 2 specification in Section 12.1 of this document.
    d. Drainage layer: Compacted crushed stone to be Class 2 in accordance with the Road Design Manual: Part 3 Clause 13.2.1.
    e. Concrete and reinforcement to be in accordance with the requirements given in Section 12.

## 7.2 Testing & Inspections

1. The *Contractor* shall carry out CBR testing at maximum 25m spacing along the centreline of all proposed roads and car parks or as requested by the *Supervisor.*
2. CBR testing shall be carried out to BS 1377-9
3. Test results shall be reported to the *Supervisor* prior to installation of materials above the test surface level.
4. Unless otherwise noted, testing to be carried out to Section 200 of the Standard Specification for Road and Bridge Construction.
5. The required wearing course and subbase thicknesses shall be determined by the resulting CBR values and conform to the details on drawing CITSO-ACM-XX-XX-DR-CE-00005.
6. Concrete shall be tested in accordance with Section 12 of this document.

## 7.3 Tolerances

1. Road setting out and tolerances to be in accordance with Section 3 of the Standard Specification for Road and Bridge Construction.

# 8. Kerbs, Footways & Paved Areas

## 8.1 Kerbs

1. Precast concrete kerbs, channels and edgings shall comply with the requirements of British Standard 7263: Precast Concrete Kerbs, Channels, Edgings and Quadrants. The date of manufacture shall be marked on each unit. If required, test certificates shall be furnished by the manufacturers.
2. Drop kerbs to be 1.8m long to suit adjacent footpaths. Paved areas surrounding drop kerbs shall be ramped at a gradient of less than 1 in 6 and provide minimum 800mm space at the back of the ramp.
3. Transition kerbs adjoining dropped kerbs shall have a gradient of less than 1 in 6.
4. Specially cast circular kerbs and quadrants shall be used where the radius is 20m or less.

## 8.2 Pavers

1. Precast concrete flags/paving slabs shall comply with British Standard 7263. Precast concrete paving slabs shall be 600 x 600 x 50 mm thick, laid on a 50 mm thick sand bed. If required, test certificates shall be furnished by the manufacturers.
2. Refer to Architect's details for interaction with building walls, foundations and render.

## 8.3 Installation

1. Finished slab levels to be installed to prevent low spots or ponding of water.
2. All kerbs, channels, edgings and quadrants shall be laid true to line and any unit found to be more than 3mm out of the line or level at either end shall be lifted and relaid.
3. Kerbs shall be bedded on a 10mm thick cement mortar (1:3) bed.
4. Kerbs shall have a concrete base and haunch as specified on drawing CITSO-ACM-XX-XX-DR-CE-00005. The concrete shall conform to the Mix 2 specification provided in Section 12 of this document.

## 8.4 Testing & Inspections

1. Testing of paving slabs shall be in accordance with BS 7263-1.
2. Testing of kerbs, channels, edgings and quadrants shall be in accordance with BS 7263-3.
3. Concrete shall be tested in accordance with Section 12 of this document.

## 8.5 Steps

1. Refer to Architect's drawings for location and dimensions of proposed steps.
2. Steps shall be formed with precast concrete paving slabs founded on mass concrete infill as specified on drawing CITSO-ACM-XX-XX-DR-CE-00005. They shall have a 175mm rise and 600mm going. The top step shall be level with the building's finished floor level (FFL)
3. The paving slabs shall be bedded on 50mm cement mortar (1:3).
4. The mass concrete infill shall conform to the Mix 2 specification provided in Section 12 of this document.

## 8.6 Ramps

1. Refer to Architect's drawings for location and dimensions of proposed ramps.
2. Ramps to be minimum 1.5m wide with maximum gradient of 1 in 12.
3. Ramps to be constructed of in-situ Mix 2 concrete with one-layer A393 mesh with 50mm cover and brushed finish perpendicular to slope. Headquarters main entrance ramp to have finish as specified within Architectural specification.

4. Compacted fill either side of the steps shall be provided up to the finished level of the steps and graded back at 1 in 3 to tie in with proposed ground levels. These embankments shall be topped with a 150mm layer of topsoil and grassed. Such grading shall be installed to prevent low spots.

# 9. Concrete Slabs

## 9.1 General

1. The locations of proposed concrete slabs are shown on CITSO-ACM-04-XX-DR-CE-00001 and CITSO-ACM-09-XX-DR-CE-00001 and includes the following slabs:
    a. Generator Slab (x2) – included within Enabling Works package
    b. Refuse Store (x2)
    c. Medical Centre Ambulance Drop-Off area
    d. Building signage (x2) – refer to CITSO-ACM-04-GF-DR-AR-9040.
2. Refer to Section 12 for concrete specification.

## 9.2 Refuse Store Slabs

1. Concrete to be Grade C30/37 and 250mm thick overlying 50mm thick blinding concrete of Grade C16/20.
2. The top face of the slab shall receive a brushed finish.
3. One layer of A393 mesh reinforcement to be provided in top and bottom face with 55mm cover on all sides.
4. Reinforcement bars shall be Grade B500B or B500C to BS 4449:2005 or equivalent approved, with a minimum yield strength of 500 MPa. Minimum reinforcement lap lengths are to be 40 times the bar diameter.
5. Any loose/soft material (cu <40 kPa)/ organic-rich/deleterious material identified at the formation level shall be removed and replaced with compacted fill material, Type 1 in accordance with the table in Section 9.4, up to a maximum depth of 1.5m below formation level. The Type 1 fill shall be compacted in 150mm layers and shall be proof rolled. Granular sub-base material
6. All exposed edges that do not sit flush with surrounding paved levels, shall be provided with 25mm chamfers.
7. Refer to Structures and Architecture drawings for details of refuse shelter construction and foundations.

## 9.3 Ambulance Area Slab

1. Refer to CITSO-ACM-09-XX-DR-CE-00102 for details.
2. Refer to Section 7.1 for material specifications.
3. The top face of the slab shall receive a brushed finish in the direction of fall.
4. Reinforcement bars shall be Grade B500B or B500C to BS 4449:2005 or equivalent approved, with a minimum yield strength of 500 MPa. Minimum reinforcement lap lengths are to be 40 times the bar diameter.
5. Construction, expansion and isolation joints shall be located as shown on CITSO-ACM-09-XX-DR-CE-00102.
6. Filler board for expansion joints shall be 25 mm thick unless otherwise shown in the drawings, within a tolerance of ± 1.5 mm. It shall be a firm compressible material or a bonded combination of compressible and rigid materials of sufficient rigidity to resist deformation during the passage of the concrete paving plant. The depth of the joint filler board for manhole and gully slabs shall be the full depth of the slab less the depth of the sealing groove. In expansion joints, the filler board shall have a ridged top as shown on the drawings, except where a sealing groove former is indicated on the drawings.

7. Holes for dowel bars shall be accurately bored or punched out to form a sliding fit for the sheathed dowel bar.

8. Dowel bars for construction joints to be in accordance with Section 12.28 of this document.

9. Joint sealing compounds shall be approved polysulphide based compounds suitable for sealing joints in horizontal and vertical/sloping concrete surfaces as appropriate. Sealing compounds shall be applied strictly in accordance with the manufacturer's instructions and shall completely fill the joint recess. Surface primers shall be from the same manufacturer as the sealants themselves. Joint sealing compounds shall be entirely suitable for contact with potable water where these are used in water retaining structures.

10. All exposed edges that do not sit flush with surrounding paved levels, shall be provided with 25mm chambers.

11. Refer to Structures and Architecture drawings for details of refuse shelter construction and foundations.

## 9.4 Granular sub-base material

1. Granular sub-base material shall be natural sands, gravels, crushed rock, crushed slag, crushed concrete or well burnt non-plastic shale. The material shall be well graded and lie within the following grading limits:

| BS 410-1 and BS 410-2 Test Sieve | Percentage by mass passing | |
|---|---|---|
| | Type 1 | Type 2 |
| 75 mm | 100 | 100 |
| 37.5 mm | 85 – 100 | 85 – 100 |
| 20 mm | 60 – 100 | 60 – 100 |
| 10 mm | 40 – 70 | 40 – 70 |
| 5 mm | 25 – 45 | 25 – 85 |
| 600 µm | 8 – 22 | 8 – 45 |
| 75 µm | 0 – 10 | 0 – 10 |

2. Where granular sub-base material is to be used within 450 mm of the surface of any road, the material shall have a heave not greater than 15 mm when tested in accordance with BS 812-124.

3. Natural sands and gravels shall be permitted in Type 2 material. Natural sands up to 12% only shall be permitted in Type 1 material.

4. The particle size shall be determined by the washing and sieving method of BS EN 933-1. The material passing a 425 µm BS sieve, when tested in accordance with BS 1377-2, shall be non-plastic for Type 1 and have a Plasticity Index of less than 6 for Type 2.

5. With the exception of well burnt non-plastic shale, the material shall have a “ten per cent fines” value of 50 kN or more when tested in accordance with BS 812-111.

6. Type 1 material shall be delivered to Site with a moisture content within + 1% and – 2% of optimum as determined in accordance with BS 5835-1, and shall be protected, so as to be maintained within this range, until its incorporation into the Works.

7. Recycled materials shall comply with all relevant Standards and this clause.

# 10. Electrical Ducts

1. Pipes, joints and fittings for buried ducts shall have flexible mechanical joints and comply with the relevant provisions of the appropriate Standard, as set out below:

| Type | Standard |
|---|---|
| Unplasticized PVC | BS 4660 or EN 1401-1 |
| Structured wall plastics pipes | EN 61386-24 |

2. All cable ducts shall be fitted with draw cords.

3. Pipes for cable ducts shall be coloured as follows:

| Duct | Colour |
|---|---|
| Electricity | Black |
| Electrical signal and telecoms cables | Grey |
| Cable TV | Green |
| Street lighting | Orange |

# 11. Excavation, backfilling and restoration

## 11.1 General

1. Unless stated otherwise, earthworks shall be carried out in accordance with the Standard Specification for Road and Bridge Construction.

2. Earthworks material within the site at the commencement of the works shall remain the property of the *Client* except when stated.

3. The design of Temporary Works associated with earthworks, including temporary slopes, stockpiles and drainage, shall be such that the risk of failure is not more than that which would be adopted if the Temporary Works were to be permanent. Allowance may be made in the design of the Temporary Works for the shorter design life and for the risk to persons and property and the surface water and groundwater conditions which are likely to occur during construction.

4. Different types of earthworks material shall be kept separate from each other. Earthworks material which is suitable for use as fill material shall be maintained in a suitable condition and shall not be contaminated.

5. Earthworks after site clearance, excavation or filling and earthworks material after excavation shall be kept free from water and shall be protected from damage due to water and from exposure to weather conditions which may affect the earthworks or earthworks material. The measures to be taken shall include the following:

    a) As stated in Clauses 10.11.

    b) Surfaces shall be maintained in a stable condition and shall be formed to falls to shed water and to prevent ponding.

    c) The area of exposed surfaces shall be kept to a minimum.

    d) Temporarily exposed surfaces shall be sealed or covered with impermeable sheeting or protected by other methods approved by the Engineer.

9. Earthworks material which has been used, or is required for use, in the permanent work and which is allowed to become unsuitable such that in the opinion of the *Supervisor* it no longer complies with the specified requirements for that type of material shall be replaced or dealt with by methods agreed by the *Supervisor*.

10. Earthworks material which is not stated in the Contract to be excavated and which the *Contractor* causes or allows to deteriorate such that in the opinion of the *Supervisor* the permanent work will be affected shall be replaced or dealt with by methods agreed by the *Supervisor.*

11. Material provided to replace earthworks material which has been allowed to become unsuitable or which the *Contractor* causes or allows to deteriorate shall be an equivalent material approved by the *Supervisor*. The replacement material shall have the same volume after compaction as the material replaced.

12. The material which is to be replaced shall be disposed of by the *Contractor.*

13. Earthworks material which is required for use in the permanent work as fill material shall not be removed from the Site unless permitted by the Engineer. The *Contractor* shall notify the *Supervisor* before any earthworks material is removed from the Site.

14. Areas to be stripped of topsoil shall first be scraped clean of all brush, weed, grass, roots and other material.

15. Unless stated otherwise, sampling and testing shall be in accordance with Section 200 of the Standard Specification for Road and Bridge Construction.

## 11.2 Particulars for Earthworks

1. The following particulars of the proposed materials and methods of construction for earthworks shall be submitted to the *Supervisor*:

    a) details of Constructional Plant and haulage vehicles,

    b) methods of excavation and of deposition and compaction of fill material,

    c) use of different types of excavated material and sources of imported fill material,

    d) arrangements for stockpiling excavated material and fill material and for disposing of earthworks material,

    e) methods of controlling the moisture content of fill material,

    f) methods of controlling surface water and groundwater and of protecting earthworks and earthworks material from damage due to water and from weather conditions which may affect the earthworks or earthworks material,

    g) methods of monitoring groundwater levels, and

    h) methods of monitoring the ground and structures for movements.

2. The particulars shall be submitted to the *Supervisor* at least 14 days before the relevant work starts.

## 11.3 Excavation

1. Blasting for excavation is not permitted unless agreed with *Supervisor*.
2. Operations shall be carried out in such a manner as to prevent damage to, or deterioration of, the formation of excavations.
3. Excavations in locations where services may be encountered shall be carried out in accordance with 'HSG 47 Avoiding Danger from Underground Services'.
4. Unsuitable ground or damaged surfaces below formation shall be excavated and then filled to formation level, with the material shown on the drawings or otherwise specified in the Contract. Any void that results from over-excavation shall be filled with the material stated in the Contract.
5. Excavated granular material which can be reused shall be kept separate from excavated cohesive materials.
6. Excavations for structures, pits and trenches shall not be carried out on or adjacent to slopes unless measures are taken to drain the excavation and to prevent water from the excavation entering the slope.
7. The *Contractor* shall inform the *Supervisor* without delay of the nature and location of any unforeseen obstruction encountered during excavation.
8. Boulders which intersect the earthworks final surface or formation shall be dealt with as excavation proceeds by methods agreed by the *Supervisor*. Boulders shall not be left protruding unless permitted by the *Supervisor*.
9. Constructional Plant or other vehicles shall not be operated or parked adjacent to excavations and earthworks material or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation.
10. Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.
11. Unless otherwise permitted by the *Supervisor* excavations next to structures shall be carried out by hand.
12. Stability of excavations for structures shall be ensured either by means of a support system or by battering the excavation sides to a stable slope which can be maintained during the works or by

other suitable means. The maximum depth of unsupported excavations with vertical sides shall be 1.4m.

13. Areas to be stripped of topsoil shall first be scraped clean of all brush, weeds, grass, roots and other material that will interfere with plant bed maintenance.

14. Trenches for pipes carrying water shall, except where stated otherwise, be excavated to a sufficient depth to ensure a minimum cover of 900mm to the top of the pipes where vehicle loading is expected and 600mm cover to top of pipe in non-trafficked areas.

15. Trenches shall be excavated so that the effective width is maintained within any limit imposed by the design of the pipeline. The sides of excavations shall be adequately supported at all times and, except where described in or permitted under the Contract, shall not be battered.

16. The length of trench excavation left open at any one time shall not exceed that agreed by the *Supervisor*.

17. Unless permitted by the *Supervisor*, trenches for utilities in areas of fill shall not be excavated until the fill material has been deposited and compacted up to the earthworks final surface or formation or up to 1 m above the top of the utility, whichever is lower.

## 11.4 Completion of earthworks surfaces

1. Earthworks final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.

2. Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract.

3. Formations above structures or utilities shall be completed after construction of the structure or utility.

4. Except in excavations in rock and in areas of fill formed of rock fill material, formations shall be compacted to obtain a relative compaction of at least ± 2% optimum to a depth of 200 mm below the formation.

5. Unless otherwise permitted by the *Supervisor*, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the *Supervisor* by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 kN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the *Supervisor* is excessive shall be made good as instructed by the *Supervisor*.

6. After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 kN.

7. Unless otherwise permitted by the *Supervisor*, formations which will not be immediately covered by the subsequent permanent work shall be protected by methods agreed by the *Supervisor.*

8. Earthworks final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.

9. Formations shall not be used by Constructional Plant or vehicles other than those which in the opinion of the Engineer are essential to construct the subsequent work.

## 11.5 Topsoil for re-use

1. “Topsoil” shall mean the top layer of soil that can support vegetation.

2. Topsoil shall be removed where indicated on the design drawings. Where required for re-use it shall be stockpiled separately and kept free from weeds. Topsoil stockpile height shall be a maximum of 4m high.
3. Topsoil stripping, stockpiling and replacement shall be conducted in such a manner as to minimise damage to the soil structure.

## 11.6 Topsoiling and grassing

1. The *Contractor* shall provide protection to all cut slopes, shoulders, and swale bases by topsoiling and grassing. This shall include all areas identified as cut slopes on CITSO-ACM-04-XX-DR-CE-00002 and CITSO-ACM-09-XX-DR-CE-00002.
2. Topsoil on sloped surfaces shall be scarified to a depth of 150mm prior to seeding.
3. The extent of landscaped areas to be provided with 150mm topsoil and seeded is shown on CITSO-ACM-04-XX-DR-CE-00001 and CITSO-ACM-09-XX-DR-CE-00001 as ‘Grassed Areas’.

## 11.7 Grass seed

1. Selected grass seed shall be proposed by *Contractor* and agreed with *Supervisor* prior to planting.

## 11.8 Dealing with water

1. All necessary precautions shall be taken to prevent any adjacent ground from being adversely affected by loss of fines through any dewatering process.
2. Groundwater shall not be allowed to enter mains to be used for the conveyance of potable water.

## 11.9 Backfilling

1. Backfilling shall, wherever practicable, be undertaken immediately after the specified operations preceding it have been completed. Backfilling shall not, however, be commenced until the Works to be covered have achieved a strength sufficient to withstand all loading imposed thereon.
2. Backfilling shall be undertaken in such a manner as to avoid uneven loading or damage.
3. Filling material to excavations shall be placed and compacted to form a stable backfill. Selected fill, whether from locally excavated material or imported, shall consist of uniform, readily-compactible material.
4. Where the excavations have been supported and the supports are to be removed these, where practicable, shall be withdrawn progressively as backfilling proceeds, in such a manner as to minimise the danger of collapse, and all voids formed behind the supports shall be carefully filled and compacted.

## 11.10 Filling above ground

1. Embankments and other areas of fill shall be formed of suitable materials capable of normal compaction to form a stable fill, deposited and compacted as soon as practicable after excavation, in layers of thickness appropriate to the compaction plant used.
2. The filling shall, where practicable, be built up and compacted evenly, and shall be maintained at all times with a sufficient camber or cross fall and a surface sufficiently even to enable surface water to drain readily from it.

## 11.11 Deposition of fill material

1. Fill material shall be obtained from excavation within the Site. If there is insufficient fill material of the required types within the Site, imported fill material shall be provided by the *Contractor* from sources outside the Site.
2. Except as stated in temporary cases, surfaces on which fill material is to be deposited shall be prepared after site clearance in accordance with the following requirements:

1. Topsoil, grass, and other organic matter shall be removed.
2. Soft spots, boulders and other materials which in the opinion of the *Supervisor* are unsuitable or unstable shall be removed.
3. Watercourses shall be diverted as stated in the Contract.
4. Benches shall be cut and sub-soil drainage systems installed as stated in the Contract.
5. Voids shall be dealt with as stated in the Contract or instructed by the *Supervisor*.
6. Surfaces other than rock shall be scarified to a depth of 200 mm and compacted to the same standard as the fill material which is to be deposited.

3. The permission of the *Supervisor* shall be obtained before deposition of fill material starts in any area of fill.
4. Haulage of fill material to an area of fill shall proceed only when the compaction plant operating at the area to be filled is sufficient to achieve the specified requirements for relative compaction of the fill material.
5. Fill material obtained from excavations within the Site shall be deposited in its final location as soon as practicable after it has been excavated.
6. Fill material shall be deposited in layers of a thickness appropriate to the compaction method to be used.
7. Unless otherwise permitted by the *Supervisor*, layers of fill material shall be horizontal, except for any gradient required for drainage, and the thickness of each layer shall be uniform over the area to be filled.
8. Except in excavations for structures, pits and trenches, if the difference in level between adjacent areas to be filled exceeds 1 m the edge of the higher area shall be benched before fill material is placed against it.
9. The construction of the Works shall be controlled in such a manner that any compaction of the fill material resulting from the passage of Constructional Plant or haulage vehicles is uniform.
10. In areas of fill formed of fill material other than rock fill material, earthworks final surfaces sloping at a gradient exceeding 1 vertical to 3 horizontal shall be formed by overfilling and cutting back after compaction. Over-filling shall extend beyond the earthworks final surface by a horizontal distance of 0.5 m or three times the thickness of the compacted layer, whichever is greater.
11. Except for around pipes, fill material deposited within 0.5 m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.
12. Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.

## 11.12 Compaction of fill material

1. Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.
2. The permission of the *Supervisor* shall be obtained before the next layer is deposited on each layer of compacted fill material.
3. Unless stated otherwise, fill material shall be compacted to obtain a relative compaction of at least +/2% of optimum throughout unless stated otherwise.
4. Fill material other than rock fill material shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be ±3%, provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content.

5. Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.
6. Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.
7. The final compacted thickness of each layer of rock fill material shall exceed 1.5 times and shall not exceed twice the nominal Grade size of the rock fill material.
8. The surface voids of each layer of rock fill material shall be filled with fragments of rock before the next layer is deposited. The final surface of rock fill material shall also be blinded with fine fill material.
9. Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and at least 4 kN for layers with a compacted thickness exceeding 500 mm.

## 11.13 General filling materials

1. Hardcore shall consist of clean, hard, durable material, uniformly graded from 200 mm to 20 mm and be free from extraneous matter.

2. Selected fill, whether from locally excavated material or imported, shall consist of uniform, readily compactible material.

3. Fill shall be free from organic matter, building rubbish and frozen material or materials susceptible to spontaneous combustion. It shall exclude clay of liquid limit greater than 80 and/or plastic limit greater than 55, and materials of excessively high moisture content. Clay lumps and stones retained on 75 mm and 37.5 mm sieves, respectively, shall be excluded from the fill material.

4. The soluble sulphate content of fill material placed within 500mm of concrete, cement bound material or cementitious material shall not exceed 1.9g of sulphate, expressed as SO3, per litre.

5. The total sulphate content, expressed as SO3, of fill material placed within 500mm of metal work shall not exceed 0.5% by mass.

## 11.14 Tolerances

1. Earthworks final surfaces and formations shall be within the tolerances stated in the table below. The tolerances for formations do not apply for pipes or preformed structures which require to be supported over their complete length or area.
2. In excavation, a positive tolerance refers to insufficient excavation and a negative tolerance refers to excess excavation. In areas of fill, a positive tolerance refers to excess fill material and a negative tolerance refers to insufficient fill material.

**Tolerances for earthworks final surfaces and formations**

| Type of surface | Method of forming surface | Tolerance (mm) | |
|---|---|---|---|
| | | + | - |
| Formations for structures and utilities | Excavation except in rock | 0 | 25 |
| | Excavation in rock | 0 | 150 |
| | Deposition and compaction of fill material | 0 | 25 |
| Formations for pavements, including carriageways, footways, cycle tracks andpaved areas. | Excavation except in rock | 0 | 50 |
| | Excavation in rock | 0 | 150 |
| | Deposition and compaction of fill material | 0 | 50 |
| Earthworks final surfaces other than formations, with a gradient not exceeding 1 vertical to 10 horizontal | Excavation except in rock | 0 | 100 |
| | Excavation in rock | 0 | 200 |
| | Deposition and compaction of fill material | 0 | 100 |
| Other earthworks final surfaces | Excavation except in rock | 100 | 100 |
| | Excavation in rock | 100 | 200 |
| | Deposition and compaction of fill material | 100 | 100 |

## 11.15 Reinstatement of Unpaved Land

1. The surface of all land affected shall be broken up, to a depth of at least 300 mm, and stones and extraneous material greater than 50 mm in size cleared before topsoil is replaced. The land shall be cultivated and restored as closely as possible to its original condition.

## 11.16 Disposal of Material

1. Earthworks material, which is suitable for filling above ground, that is required to be removed from the site shall remain the property of the *Client* and be moved by the *Contractor* to the location highlighted in red in the figure below, where it shall be placed and compacted as agreed with the *Project Manager* and KDF.

**Figure 1 - Location for disposal of suitable filling material.**

2. Earthworks material which is unsuitable for filling above ground and is required to be disposed of by the *Contractor*, shall become the property of the *Contractor* when it is removed from the site and shall be disposed of in tippers provided by the *Contractor*.

3. The burning of material on Site arising from the Site is not permitted.

# 12. Concreting and formwork

## 12.1 General

1. Concrete works shall be carried out in accordance with Section 17000 of the Standard Specification for Road and Bridge Construction.

2. Concrete shall conform to one of the mix specifications provided below:
   a) Structural concrete:

### Mix 1 Specification

| Type | Designed | |
|---|---|---|
| Compressive strength class | C30/37 | |
| Intended working life | 50 | [years] |
| DC-class[(a)] | DS-2 | |
| ACEC class[(a)] | AC-3z | |
| Chloride content class | Cl 0.40 | |
| Exposure class[(b)] | XC2, XD2, XA2 | |
| Maximum w/c ratio | 0.5 | |
| Cement type[(c)] | CEM III/A | |
| Minimum cement content | 320 | [kg/m$^3$] |
| Maximum cement content | 400 | [kg/m$^3$] |
| Aggregate type | TBC | |
| Maximum aggregate size | 20 | [mm] |
| Consistence class | S3 | |

**Notes:**
(a) In accordance with the GIR report
(b) Exposure classes are in accordance with KS EAS 131-1:2008
(c) In accordance with EAS 18-1. Alternative cement combinations may be proposed by the *Contractor* subject to agreement with the *Supervisor.*

   b) Non-structural concrete:

### Mix 2 Specification

| Type | Designed | |
|---|---|---|
| Compressive strength class | C16/20 | |
| Intended working life | 50 | [years] |
| DC-class[(a)] | DS-2 | |
| ACEC class[(a)] | AC-3z | |
| Chloride content class | - | |
| Exposure class[(b)] | - | |
| Maximum w/c ratio | - | |
| Cement type[(c)] | CEM I, CEM IIA, IIB-S, IIB-V, IIIA, IVB-V | |
| Minimum cement content | 220 | [kg/m$^3$] |

| | | |
|---|---|---|
| Maximum cement content | - | [kg/m$^3$] |
| Aggregate type | TBC | |
| Maximum aggregate size | 20 | [mm] |
| Consistence class | S3 | |

**Notes:**
(a) In accordance with the GIR report
(b) Exposure classes are in accordance with KS EAS 131-1:2008
(c) In accordance with EAS 18-1. Alternative cement combinations may be proposed by the *Contractor* subject to agreement with the *Supervisor.*

## 12.2 Concrete – general

1. Concrete shall be produced, transported and accessed in accordance with KS EAS 131-1.

2. The cementitious content of concrete designed to retain an aqueous liquid shall be between 325-400 kg/m3 with a maximum free water/cementitious ratio of 0.55.

3. The maximum size of aggregate in any structural member shall not exceed 20mm or 25% of the minimum thickness of the member, whichever is smaller.

4. Conformity control and criteria shall be undertaken in accordance with KS EAS 131-1 Clause 8.

5. Where identity testing is specified as defined in KS EAS 131-1, Annex B for strength, it shall be undertaken in accordance with KS EAS 131-1, Annex B as follows:

| Type of structure | Sample to represent a volume of (m$^3$) |
|---|---|
| Buried concrete water retaining tanks | 10 |
| All other concrete construction | 50 |

## 12.3 Concrete – ready-mixed

1. The delivery ticket required for each load of ready-mixed concrete shall, in addition to the information prescribed under KS EAS 131-1 Clause 7.3, detail:

    a) the type of aggregate;

    b) the actual cementitious content and the percentage of any PFA or

    c) GGBS included; and the position of the concrete in the Works (details to be inserted at the point of discharge).

2. All delivery tickets shall be kept at the Site and shall be made available for inspection.

## 12.4 Concrete – porous no-fines

1. Porous no-fines concrete shall contain CEM 1 cement to KS EAS 131-1, and 20-10 mm aggregate complying with BS EN 12620, in a proportion of 1:10 by mass.

2. The concrete shall be mixed to a uniform colour and consistency, with the addition of water sufficient only to coat all of the aggregate without forming excess grout.

## 12.5 Cement

1. Cement shall be either be combinations complying with EAS 18-1.

## 12.6 Supply of information

1. Before any concrete is supplied and not less than 7 days before the start of the concrete production, all pertinent information specified in KS EAS 131-1 Clause 7.2 shall be exchanged and agreed with the producer.

## 12.7 Admixtures for concrete or grout

1. Admixtures for use in concrete or grout shall comply with the relevant provisions of EN 934-2 and shall be approved by the engineer prior to inclusion.

## 12.8 Aggregates for concrete

1. Aggregates for concrete shall comply with the relevant provisions of EN 12620:2000.

2. The water absorption of aggregates for concrete designed to retain an aqueous liquid shall not exceed 3% when measured in accordance with EN 1097-6.

3. Recycled aggregates are not permitted for use.

## 12.9 Aggregates for mortar

1. Fine aggregates for mortar shall be washed natural sand or crushed natural stone and shall comply with EN 13139.

## 12.10 Initial Testing

1. Initial testing shall be undertaken for each classification of structural concrete.

2. Such testing shall be in accordance with KS EAS 131-1 Clause 9.5, Clause 10 and Annex A.

## 12.11 Identity Testing

1. Identity testing for slump, flow and air content of individual batches shall be tested in accordance with Table 18 of KS EAS 131-1.

2. Identity testing for compressive strength shall be undertaken in accordance with Annex B of KS EAS 131-1 as follows:

| Type of structure | Sample to represent a volume of [$m^3$] |
|---|---|
| Buried water retaining tank | 10 |
| Generator slab | 10 |

## 12.12 Transporting, placing and compacting

1. Concrete shall be transported from the mixer to, or as close as possible to, its final location with minimum delay so that it is placed before it becomes difficult to place and/or compact.
   (a) Do not transport concrete in a manner likely to cause ingredients to separate.
   (b) Keep containers clean.

**Notes:**
If the concrete is transported in containers e.g. dumpers, barrows, etc. that will bump up and down over rough ground, there will be a tendency for stone particles to sink towards the bottom. Avoid rough tracks as far as possible. In hot weather conditions the concrete should be covered during transporting.

2. Concrete shall be transported in:
   (a) A truck mixer or agitator; or
   (b) A non-agitating vehicle where permitted by the specifier.

Where non-agitating vehicles are used, procedures shall be followed that have been proven to minimize:
(1) Segregation;
(2) Any change in entrained air content, except for the case where the loss of air has been taken into account
(3) Loss of any constituent; and
(4) Ingress of foreign matter or water

3. Adequate notice shall be given to the *Supervisor* of the intention to commence concreting.

4. Concrete shall be delivered within 2 hours after the time of loading where transported in truck mixers or agitators or within 1 hour after the time where non-agitating equipment is used.

5. Concrete shall be thoroughly compacted in its final position within 30 minutes of commencing discharge. The plant used for compaction shall be operated continuously during the placing of each batch of concrete until the expulsion of air has virtually ceased, and in a manner which does not promote segregation of the ingredients.

6. Whenever vibration has to be applied externally, the design of formwork and disposition of vibrators shall be such as to ensure efficient compaction and to avoid surface blemishes.

## 12.13 Concrete temperature

1. The temperature of the fresh concrete at the point and time of delivery shall not exceed 20°C. This shall be monitored immediately prior to pouring. Cement shall not be permitted to come into contact with water at a temperature greater than 60°C.

2. Where the temperature of the fresh concrete is likely to exceed the temperature specified above, concreting shall not be permitted.

## 12.14 Curing

1. Curing of concrete shall be carried out in accordance with ENV 13670-1.

2. Fresh concrete should be watered a minimum of 3 times a day for at least 7 days after removal of formwork and should be covered with protective sheeting between waterings.

3. Components which are intended to have similar exposed surface finish shall be cured in the same manner.

## 12.15 Records of concreting

1. Up-to-date records of the dates and times when concreting is carried out, and of the weather and temperature at those times, shall be kept. The records shall be available for inspection.

2. Sufficient records shall be maintained to enable every batch of concrete and its location within the Works to be identified.

## 12.16 Construction of formwork

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

2. The forms shall be capable of producing a consistent quality of surface, as described in the Contract.

3. Where holes are required in forms to accommodate projecting reinforcement, fixing devices or other built-in items, precautions shall be taken to prevent loss of the mortar matrix.

4. Formwork shall give access for the preparation of joint surfaces before the concrete has hardened.

5. For the purposes of compliance with the provisions of 12.18, the method of constructing formwork shall allow for props to soffit forms to remain in position continuously for the period described.

6. All exposed vertical and horizontal edges of concrete shall have 25 mm x 25 mm chamfers. Chamfers shall extend to 150 mm below finished ground level.

## 12.17 Cleaning and treatment of forms

1. The interiors of all forms shall be thoroughly cleaned out before any concrete is placed. The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent, where applicable.

2. Where a concrete surface is to be permanently exposed, only one release agent shall be used throughout the entire area. Release agents shall be applied evenly and contact with reinforcement and other embedded items avoided. Where the concrete surface is to receive an applied finish, care shall be taken to ensure the compatibility of the release agent with the finish.

## 12.18 Striking of formwork

1. Formwork shall be removed without shock to, or disturbance of, the concrete.

2. Formwork to vertical surfaces or sloping formwork not supporting concrete in flexure shall not be removed until the concrete strength shall be sufficient to meet any loading upon the concrete likely to arise at the time when the formwork is removed, and:
   a) the concrete strength (as confirmed by tests in cubes cured under representative conditions) has reached 5 N/mm2; or
   b) for concrete containing cement to EAS 18-1 CEM I 42.5, 52.5 only, in the absence of cube test results, a minimum period shall have elapsed since the concrete was poured equivalent to 11 hours at 15°C for unsealed plywood forms or 8 hours at 15°C for impermeable forms.

3. Formwork supporting concrete in flexure shall not be removed until:
   a) the concrete strength (as confirmed by tests on cubes cured under representative conditions) has reached 10 N/mm2, or twice the stress to which the concrete will then be subjected, whichever is the greater; or
   b) for concretes containing cement to EAS 18-1 CEM I 42.5, 52.5, in the absence of cube test results or any formal procedure agreed in writing, the periods before striking calculated from the relevant formula given in the following table shall be used.

| Type of formwork | Period calculated for mean ambient temperature (t) between 0°C and 25°C using formulae below |
|---|---|
| Soffit forms to slabs and beams | $\frac{100}{t+10}$ days |
| Props to slabs and beams | $\frac{250}{t+10}$ days |

4. Sufficient records to identify the time from pouring of any section to the striking of the formwork on the same shall be maintained on Site for inspection.

**Notes:**

(i) It should be noted that 11 hours at 15°C is equivalent to:
- 8 hours at 20°C
- 15 hours at 10°C
- 24 hours at 5°C

(ii) It should be noted that 8 hours at 15°C is equivalent to:

- 6 hours at 20°C
- 12 hours at 10°C
- 18 hours at 5°C

## 12.19 Steel reinforcement

1. Steel reinforcement shall comply with the relevant provisions of the relevant provisions of the appropriate Standard, as set out below:

| Type | Standard |
|---|---|
| Carbon steel bars | BS 4449 |
| Steel wires | BS 4482 |
| Steel fabric | BS 4483 |

2. Steel fabric reinforcement shall be welded at the intersections and shall be delivered in flat sheets, except where pre-bent reinforcement is specified.

## 12.20 Cutting and bending of reinforcement

1. Cutting and bending of reinforcement shall be in accordance with BS 8666.

2. Except for the use of proprietary starter bar systems, reinforcement shall not be straightened or re-bent. When using proprietary systems and bending projecting reinforcement, care shall be taken not to damage the concrete and to ensure that the radius is not less than the minimum specified in BS 4466.

3. All starter bars shall be capped with “mushroom caps” until the next set of reinforcing bars are fixed in place.

## 12.21 Fixing of reinforcement

1. Reinforcement shall be firmly supported and secured against displacement, in accordance with BS 7973-2.

2. Non-structural connections for the positioning of reinforcement shall be made with tying wire or other fixing devices. Projecting ends of ties or clips shall not encroach into the concrete cover.

3. Concrete cover shall not be less than the nominal cover minus 10 mm or greater than the nominal cover plus 15 mm. Refer to detail drawings for the nominal cover for each concrete element.

4. Reinforcement shall be inspected by the *Supervisor* prior to encasing in concrete. The *Contractor* shall give the *Supervisor* sufficient notice of required inspections.

## 12.22 Surface condition of reinforcement

1. Concrete shall not be placed until reinforcement is free from any substance which might adversely affect the steel or concrete chemically, or reduce the bond.

## 12.23 Laps and joints

1. Laps and joints in reinforcement shall be made only at the positions described on the Drawings.

## 12.24 Welding of reinforcement

1. Reinforcement shall not be welded on site.

## 12.25 Built-in items

2. Where pipes, sleeves, water bars or other items are designed to be cast into concrete, they shall be constructed and installed in order to ensure that they are:

a) securely and rigidly retained in position;
b) watertight for the design life of the fittings and structure;
c) resistant to corrosion for the design life;
d) adequately bonded to the concrete; and
e) free from external coatings that may reduce the bond.

3. Precautions shall be taken to prevent the formation of air pockets, voids or other defects whilst the concrete is being placed.

## 12.26 Compressible filler and packing for pipelines

1. Compressible filler for interrupting concrete protection to pipelines shall consist of bitumen-impregnated insulating board to EN 622-1 and EN 622-4. The thickness of compressible filler shall be as follows:

| Nominal bore of pipe (mm) | Thickness of compressible filler (mm) |
|---|---|
| Less than 450 | 18 |
| 450-1200 | 36 |
| Exceeding 1200 | 54 |

2. Compressible packing for use between pipes and precast concrete setting blocks shall consist of bitumen damp-proof sheeting, complying with BS 6398.

3. Bituminous materials shall not be put into contact with plastics pipes.

## 12.27 Construction joints

1. Concreting shall be carried out continuously up to construction joints.

2. Concrete shall not be allowed to taper off to a thickness of less than 50 mm. Vertical joints shall be formed against a stop board, suitably notched to accommodate the reinforcement. The top surface of each lift of concrete shall be straight and level.

3. Where a kicker is used, it shall be at least 70 mm high and shall be cast integrally with the slab.

4. The surface of any concrete against which new concrete is to be cast shall be free from laitance and shall be roughened to the extent that the large aggregate is exposed but not disturbed. The joint surface shall be cleaned immediately before the fresh concrete is placed against it.

5. Where practicable, such preparation of joints shall be carried out when the concrete has set but not hardened.

## 12.28 Dowel bars

1. Dowel bars for expansion joints in concrete shall consist of mild steel complying with the provisions of EN 13877-3.

## 12.29 Bond breaking compound for dowel bars

1. For water-retaining structures, bond breaking compound for dowel bars shall not contain materials likely to adversely affect potable water contained within the structure. The compound shall be constituted such that it will perform effectively for the design life of the concrete. It shall in no way retard or otherwise affect the setting of concrete.

## 12.30 Surface finishes produced without formwork

1. The concrete shall be levelled and screeded to produce a uniform plain or ridged surface, as required. No further work shall be applied to the surface unless it is a first stage for a wood float or steel trowel finish.

2. The screeded finish shall be wood floated under light pressure to eliminate surface irregularities.

3. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the surface to the wood float finish shall be steel-trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

4. Power floating shall be undertaken by steel floating the concrete to an even finish with no ridges or steps. When the concrete has taken a primary set, it shall be power trowelled to a uniform smooth polished surface free from trowel marks or other blemishes. Once power floating is completed, the surface finish must be adequately protected from construction traffic.

5. Where the type of finish is not given, it shall be wood float finish.

**Notes:**

The four finishes are intended to be applied as follows:

(i) Screeded - surfaces to receive further treatment or of no visual merit, or expressly suitable to their function with the workmanship as specified;

(ii) Wood Float - surfaces where a reasonably regular finish is required but appearance is not of prime importance;

(iii) Steel Trowel - surfaces where appearance is important; and

(iv) Power Float Finish - surfaces where a smooth flat finish with only minor deviations is required.

(v) Any other required finish should be described in the Contract.

## 12.31 Surface finishes produced with formwork

1. Rough finish shall be obtained by the use of moulds or properly designed forms of closely-jointed sawn boards. The surface shall be free from substantial voids, honeycombing or other large blemishes.

2. Fair finish shall be obtained from forms designed to produce a hard smooth surface with true, clean arises. Only very minor surface blemishes shall be permitted and there shall be no staining or discolouration. Any projections shall be removed and the surface made good.

3. Fair worked finish shall be obtained by first producing a fair finish and then filling all surface blemishes with a fresh, specially prepared cement and fine aggregate paste whilst the concrete is still green, where possible. After the concrete has been properly cured, the faces shall be rubbed down, if required, to produce a smooth and even surface. If the surface is to be exposed in the final work, every effort shall be made to match the colour of the concrete.

4. Liquid retaining surfaces and other surfaces exposed in the completed Works shall receive a fair worked finish. All other structural concrete surfaces shall receive a rough finish.

5. The use of controlled permeability formwork (CPF) shall be agreed with the Client. The CPF liner shall have the following minimum improvements to the outer 20 mm of the concrete:
   a) cement content of 75 kg/m3 greater than the control; and
   b) a minimum improvement of 50% for surface tensile strength, ISAT carbonation and chloride ingress.

6. The CPF liner shall be installed and used in accordance with the manufacturer‘s recommendations. Release agents shall not be used. Type III, CPF liners can be reused, subject to agreement with the Client.

## 12.32 Wearing screeds

1. Wearing screeds (granolithic finish) shall be provided, laid and finished in accordance with the relevant provisions of BS 8204-2.

2. Wearing screeds shall provide abrasion resistance to class AR4/WS of Table 4 of BS 8204-2:2003. Where high abrasion conditions are expected, wearing screeds shall provide abrasion resistance to class AR1/WS of Table 4 of BS 8204-2:2003.

3. Where concrete benching is required to have a granolithic finish with abrasion resistance to class AR4/WS of Table 4 of BS 8204-2:2003, this shall be formed with four parts 8 mm to dust to one part sulphate resisting cement placed with a steel trowel finish. Where sulphate resisting cement is unavailable, then a combination of Portland Cement (CEM 1) and GGB FS or PFA shall be used to give equivalent resistance to sulphate attacks.

## 12.33 Tie bolts for formwork

1. Tie bolts shall be of the high tensile variety, fixed perpendicular to the formwork.

2. Tie bolts shall not embed any permanent metal parts within 50 mm of the concrete surface.

3. Voids remaining after the removal of all, or part, of each tie bolt shall be sealed using a polymer-modified cementitious compound, or other suitable product, unless specified in the Contract. Metal-based expansive admixtures shall not be used. All such voids shall be prepared in accordance with the manufacturer’s instructions, prior to filling, to ensure an adequate bond is achieved.

4. Tie bolts which form a continuous hole through a structure designed to retain an aqueous liquid shall not be used.

5. In the case of structures designed to retain an aqueous liquid, any other measures securing formwork shall not impair the watertightness of the structure.

## 12.34 Tolerance for concrete surfaces

1. Concrete surfaces in the final work shall have no abrupt irregularities which are, to an extent, observable by eye. Subject to retaining the required concrete cover to reinforcement, other deviations from the surfaces described in the Contract shall be no more than the following permissible amounts:

| Type of finish | Deviation from line, level, vertically, cross-sectional, dimension or length (mm) |
|---|---|
| Screeded or rough | 10 |
| Power float | 3 |
| Any other | 5 |

## 12.35 Cement grouts

1. Cement grout shall be mixed in the relevant proportions indicated in the following table, using the minimum quantity of water to ensure the necessary fluidity and to render it capable of penetrating the work.

| Class | Normal mix by class |
|---|---|

| | Cement | Sand | Pfa |
|---|---|---|---|
| G1 | 1 | - | - |
| G2 | 1 | 3 | - |
| G3 | 1 | 10 | - |
| G4 | 1 | - | 10 |
| G5 | 1 | - | 4 |
| G6 | 1 | - | 0.5 |

2. Cement grout shall be used within one hour of mixing, except where containing a grout retardant admixture.

3. Cement for fixing inserts and below plant bases shall include an approved expanding additive.

## 12.36 Grout quality control testing

1. Where tests are required for different properties of grout, they shall be carried out on samples from the same batch.

2. The density and workability of every batch shall be determined. The density shall not differ from the value described in the Contract by more than 5%. The workability shall not differ by more than 125 mm for the “Concrete Flow Through Test” or 5 seconds for the “Marsh Cone Test” with 10 mm orifice, from the values described in the Contract.

3. Sampling shall be at the rate of three cubes taken from every 5 $m^3$ of grout or 50 m of grouted annulus, whichever is smaller. When tested in accordance with the relevant provisions of BS 4551, cubes shall have a compressive strength, as given in the following table:

| Grout function | Minimum Compressive Strength at 28 days (N/mm2) |
|---|---|
| Annulus filling: | |
| Type 1 | 12 |
| Type 2 | 3 |
| Exterior void filling | 2 |

4. Cube moulds shall be 70 mm (nominal) or 100 mm, and all joints shall be sealed to prevent leakage.

5. Moulds shall be overfilled and air bubbles removed by lightly tapping the mould. After leaving for 30-60 minutes, the excess grout shall be struck off and the moulds covered with plastic sheeting or damp hessian. Moulds shall be stored at 20°C ± 5°C for 24 hours or until the grout has attained sufficient strength to allow the cube to be stripped from the mould, whichever is the greater.

6. The cubes shall be removed from the moulds, marked, and stored in water at a temperature of 20°C ± 1°C until tested.

7. Trial mixes of the grout type proposed shall be undertaken to establish the properties of the grout. The amount of bleedwater shall be determined by filling a 100 mm diameter impermeable pot to a depth of 100 mm, covered to prevent evaporation. The bleedwater shall be removed after 3 hours. The percentage volume of bleedwater after 3 hours (expressed as volume of bleedwater:volume of original sample) shall not exceed:
   a) 1% for Type I linings; or
   b) 5% for Type II linings.

## 12.37 Concrete repairs

1. All concrete repairs shall be undertaken in accordance with BS EN 1504-10 and shall be agreed with the *Supervisor* prior to repair works taking place. Test sections shall be required in order to determine the sufficiency and compatibility or otherwise, of the proposed materials and methods.

# 13. Testing and Inspections

## 13.1 Testing of Materials

1. Refer to Section 200 of the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction

## 13.2 Testing of concrete roofs

1. Concrete roofs of structures which are to contain aqueous liquids shall be watertight and shall, where practicable, be tested prior to the installation of any waterproof membrane by lagooning with water to a minimum depth of 25 mm for a period of 24 hours.

2. Where it is impracticable because of roof falls, or otherwise, to contain 25 mm depth of water, the roof shall be thoroughly wetted by continuous hosing for a period of not less than 6 hours.

3. In either case, the roof shall be regarded as satisfactory if no leaks or damp patches show in the soffit.

4. The roof covering shall be completed as soon as possible after satisfactory testing.

## 13.3 Testing of concrete structures designed to retain an aqueous liquid

1. After cleaning, and as far as practicable before any earth or other filling is placed against the outside wall faces, concrete structures designed to retain an aqueous liquid shall be filled with water at a uniform rate of not greater than 2 m in 24 hours. A period of up to 21 days shall be allowed for stabilisation, after which the water level shall be recorded at 24-hour intervals, for a test period of 7 days. During the test period, the total permissible drop, after allowing for evaporation and rainfall, shall not exceed 1/500 of the average water depth of the full tank or 10 mm, whichever is the lesser.
2. If the requirements for the 7-day test are not met then, after completion of any remedial work, the structure shall be refilled and, if necessary, left for a further stabilisation period after which the water level shall be recorded at 24-hour intervals, for a test period of 7 days.
3. Notwithstanding the satisfactory completion of the above test, any leakage visible on the outside faces of the structure shall be stopped. Any caulking or making good of cracks in the wall section shall, where practicable, be carried out from the inside face.
4. The hydraulic test shall be carried out after successful completion of the roof tests, before any disinfection work and before any sealing is undertaken.
5. Adjacent internal chambers within a structure shall be tested sequentially. Chambers adjacent to the chamber under test shall be empty during the test.
6. On satisfactory completion of the test, the structure shall be emptied, as far as practicable, unless the water can be used as part of subsequent activities.

## 13.4 Testing of Non-Pressure Pipelines

1. Non-pressure pipelines laid in open cut shall be tested after they are jointed and before any concreting or backfilling is commenced, other than such as may be necessary for structural stability whilst under test.

2. The pipelines shall be tested by means of an air or water test or by a visual or closed-circuit television (CCTV) examination, in lengths determined by the course of construction, in accordance with the programme.

3. A further test shall be carried out after the backfilling is complete.

### 13.4.1 Water Test for Non-Pressure Pipelines

1. The test pressure for non-pressure pipelines shall be not less than 1.0 m head of water above the pipe soffit or groundwater level, whichever is the higher at the highest point, and not greater than 5 m head at the lowest point of the section. Steeply-graded pipelines shall be tested in stages in cases where the maximum head, as stated above, would be exceeded if the whole section were tested in one length.

2. The pipeline shall be filled with water and a minimum period of 1 hour shall be allowed for absorption, following which the original water level shall be restored. Water shall then be added from a measuring vessel at intervals of 5 minutes over a 30-minute period and the quantity required to maintain the original water level noted. The length of pipeline shall be accepted if the quantity of water added in 30 minutes does not exceed 0.15 litres/$m^2$ for pipelines or 0.2 litres/$m^2$ for pipelines and manholes tested together, where $m^2$ refers to the total area of the wetted internal surface.

3. Following a water test, pipelines and structures shall be emptied, as far as is practicable.

### 13.4.2 Air Test for Non-Pressure Pipelines

1. Non-pressure pipelines to be air tested shall have air pumped in by suitable means until a pressure of 100 mm head of water is indicated in a U-tube connected to the system. The pipeline shall be accepted if the air pressure remains above 75 mm head of water after a period of time “t” given in the following Table without further pumping, following a period for stabilisation.

| Nominal diameter | Testing time (minutes) |
|---|---|
| DN100 | 5 |
| DN200 | 5 |
| DN300 | 7 |
| DN400 | 10 |
| DN600 | 14 |
| DN800 | 19 |
| DN1000 | 24 |

### 13.4.3 CCTV Inspection of Pipelines

1. CCTV inspections shall comply with the ‘Model Contract Document for Sewer Condition Inspection’ 1994, published by The Foundation for Water Research.

## 13.5 Concrete

1. Concrete testing generally shall be carried out to KS EAS 131-1.

2. Refer to Section 12 for details of required concrete testing.

## 13.6 Summary

| Element requiring testing & inspection | Refer to section |
|---|---|
| Testing of foul and drainage pipework | 5.2 Foul and Roof Drainage Pipework |
| Inspection of pipelines and chambers | 5.9 Testing & Inspections<br>5.15 Tolerances and Inspections |
| Testing of non-pressure pipelines | 13.4.1 Water Test for Non-Pressure Pipelines<br>13.4.2 Air Test for Non-Pressure Pipelines<br>13.4.3 CCTV Inspection of Pipelines |
| Geotextile filter material testing standards | 5.12 Geotextile Filter Material |
| CBR testing | 7.2 Testing & Inspections |
| Roads (general) | Section 200 of the Standard Specification for Road and Bridge Construction. |
| Testing and inspection of kerbs | 8.4 Testing & Inspections |
| Testing and inspection of paving slabs | 8.4 Testing & Inspections |
| Granular subbase material sieve test | 9.4 Granular sub-base material |
| Earthworks testing. | Section 200 of the Standard Specification for Road and Bridge Construction. |
| Concrete initial testing | 12.10 Initial Testing |
| Concrete identity testing | 12.11 Identity Testing |
| Grout quality control | 12.36 Grout quality control testing |
| Watertightness testing | 13.2 Testing of concrete roofs<br>13.3 Testing of concrete structures designed to retain an aqueous liquid |
| Testing of non-pressure pipelines | 13.4 Testing of Non-Pressure Pipelines |

# 14. Miscellaneous

## 14.1 Bollards

1. Location of bollards is as shown on CITSO-ACM-09-XX-DR-CE-00001

2. Bollards are to be 900-1000mm tall above finished ground level, circular in cross section of max 200mm diameter and installed at 1.5m spacings.

3. Bollards to have steel or concrete core with external material being durable, UV and weather resistant. Fixing shall not protrude above surface level nor present a trip hazard.

4. Bollards to be installed to supplier's recommendations, including foundation and fixing design.

5. Proposed bollard product to be proposed by the *Contractor* to the *Project Manager* for acceptance via the Material Approval Request (MAR) process.

## 14.2 Flagpoles

1. The Contractor is to allow for the installation of 6No. flagpoles in the positions shown on Drawing CITSO-ACM-04-XX-DR-CE-00001. This shall include provision of concrete foundation, appropriate fixing details and fittings.

2. Flagpole details to be co-ordinated with the KDF and agreed with the *Project Manager* prior to procurement.

3. The Contractor shall submit a design proposal including drawings and supporting calculations and documents to the *Project Manager* for acceptance via the Material Approval Request (MAR) process.