

**OMAN WASTEWATER  
SERVICES COMPANY S.A.O.C**



**الشركة العمانية  
لخدمات الصرف الصحي ش.م.ع.م**

**OMAN WASTEWATER SERVICES COMPANY**

**TECHNICAL STANDARD SPECIFICATION**

**CIVIL WORKS**

**SECTION 05 ROADWORKS**

Controlled Copy

## SECTION # 5 TABLE OF CONTENT

No	Description	Page
1	General	1/25
2	British Standards and American Standards	1/25
3	Work on existing Highways	1/25
4	Debris and Dust on the Public Highways	2/25
5	Prohibition of use of the Highway	2/25
6	Existing Ground Levels	2/25
7	Alternative Materials	3/25
8	Finished Levels	3/25
9	Setting Out	3/25
10	Programme/Method of Working	3/25
11	Protection of Works	3/25
12	Testing	4/25
13	Testing Facilities	4/25
14	Drains and underground services	4/25
15	Site Clearance and Earthworks	4/25
15.1	General	4/25
15.2	Site Clearance	5/25
15.3	Compaction of Existing Ground	5/25
15.4	Unsuitable Material below Formation Level	5/25
16	Excavation of Cuttings	6/25
17	Excavation of cuttings in Rock	6/25
18	Forming Embankments or other Areas of Fill	6/25
19	Compaction of Earthworks	7/25

20	Preparation and surface Treatment of Formation	8/25
21	Drainage, Flood Protection and Service Ducts	8/25
22	Compaction Equipment	9/25
22.1	Road Base Course	9/25
22.2	Laying & Compaction of Road Base Material	9/25
22.3	Road Base	9/25
23	Flexible Surfacing (Prime Coat)	10/25
24	Materials for Asphaltic Concrete Surfacing	10/25
24.1	Aggregate	10/25
24.2	Binder Course	11/25
24.3	Wearing Course and Single course (Nominal max. size 19mm)	12/25
25	Asphaltic Concrete mix Design	12/25
25.1	General	12/25
25.2	Marshall Mix Limits	13/25
26	Mixing and Laying Flexible Surfacing Materials	13/25
26.1	Mixing	13/25
26.2	Laying	14/25
26.3	Temperatures	15/25
27	Surface	15/25
27.1	Levels	15/25
27.2	Surface Regularity	16/25
27.3	Rectifications	16/25
27.4	Formation Level	17/25
28	Kerbs and Footways	17/25
29	Concrete Pavements	17/25
29.1	General	17/25
29.2	Waterproof Membrane	17/25
29.3	Joints	18/25
29.3.1	General	18/25
29.3.2	Expansion Joints	18/25
29.3.3	Contraction Joints	19/25
29.3.4	Longitudinal Joints	19/25
29.3.5	Construction Joints	20/25
29.3.7	Sealing of Joints	21/25

30	Treatments at Manholes and Gullies	22/25
31	Concrete Mixes	22/25
32	Mixing Concrete	22/25
33	Transport & Placing	22/25
34	Compacting & finishing and surface treatment	23/25
35	Curing	23/25
36	Aggregates for Concrete	24/25
37	Bond Breaking Coating for Dowel Bars	24/25
38	Cement	24/25
39	Dowel Bars and Tie Bars for Concrete Pavements	24/25
40	Cold Poured Joint Sealants and Seals	24/25
41	Preformed Joint Filler	25/25
42	Steel Reinforcement	25/25

Controlled Copy

## **SECTION # 05 ROADWORKS**

### **1. General**

Construction of all roads and footpaths will be carried out to the complete satisfaction of the Engineer. The whole of the works will be constructed in the positions and to the levels shown on the drawings, unless otherwise agreed with the Engineer. The works will be maintained by the contractor for a period as stated in the contract from the date of completion as certified in writing by the Engineer.

The contractor shall restore to the satisfaction of the Engineer any streets roads fences and other existing surfaces or erections, which may be interfered with by the construction of the works. All services, pipes and culverts or other property which may be interfered with in the progress of the works or any existing sewers to be retained are to be carefully supported or re-laid where necessary and in such a manner as the Engineer may direct and any damage done to services sewers etc. must without delay be made good by the Contractor.

All surplus materials shall be carried off site by the contractor and the site left to the approval of the Engineer. During building operations all highways adjacent to the site used by the contractor for reasons of transporting materials to and from the site shall be kept clean and free from debris by the contractor at all times. Any existing accesses to property bordering the site must be maintained at all times throughout the construction period.

The contractor shall submit for the Engineer's approval details of access routes for construction traffic prior to commencement of work.

### **2. British Standards and American Standards**

References to British Standard specifications (B.S.'s) and American Standards (AASHO and ASTM) shall refer to the latest edition or include the latest amendments of such specifications/standards.

### 3. Work on existing Highways

Where work has to be carried out on or adjacent to an existing public highway or a highway to which the public have access the contractor shall provide erect and maintain such traffic signs, lamps, barriers and such other measures as may be necessitated by the

construction of the works in accordance with the requirements of the Ministry of communications Sultanate of Oman and any additional requirements stated in the contract. Where the circumstances of any particular case are not covered by the aforementioned requirements the contractor shall submit proposals for dealing with such situations to the Engineer for approval. Compliance with this clause shall not relieve the contractor of any of his other obligations and liabilities under the Contract. Where the works involve the obstruction of a footway the Contractor shall provide an alternative safe footway properly signed, guarded and lit.

### 4. Debris and Dust on the Public Highways

Debris or other materials must not be deposited on the highway so as to damage it, obstruct it, or create a nuisance or a danger.

Highways in the vicinity of the works must be kept free from debris and dust falling from vehicles or the wheels of vehicles connected with the works or spreading from the works or associated tips.

Warning signs must be exhibited whilst work is in progress and carriageways and footways affected must be regularly cleaned.

### 5. Prohibition of use of the Highway

Existing public highways must not be used as sites for stockpiling and storing plant, vehicles, materials or equipment. The contractor shall be liable for the cost of reinstatement if damage has been caused to highways.

### 6. Existing Ground Levels

The Contractor shall satisfy himself that the existing ground levels as indicated in the contract are correct. Should the contractor wish to dispute any levels he shall submit to the Engineer a schedule of the position of the levels considered to be in error and a set of

revised levels. The existing ground relevant to the disputed levels shall not be disturbed before the Engineer's decision as to the correct levels is given.

## **7. Alternative Materials**

Where alternative specified materials are permitted the contractor shall inform the Engineer of his choice at least 4 weeks before the materials to be used or longer if such period is required for testing of the material by the Engineer. The material shall not then be changed without the Engineer's approval.

## **8. Finished Levels**

The finishing level of the work shall be as shown on the drawings.

## **9. Setting Out**

All sections of the work shall be properly set out and such setting out, together with proposed levels, shall be approved by the Engineer prior to the commencement of the particular section of the work.

## **10. Programme/Method of Working**

The contractor shall submit in writing to the Engineer for approval full details of all plant and method of working, work Programme, proposed mix designs of materials for the work prior to the commencement of the work. No operation shall be commenced until such approval has been given.

The foregoing provisions shall not prevent the Engineer from requiring the Contractor to vary his plant or methods at any time during the execution of the works should the Engineer consider it essential to ensure compliance with the Specification.

The contractor shall not vary his plant or methods, which have been approved without previously obtaining the Engineer's written approval of such variation.

## **11. Protection of Works**

The Contractor shall protect partially completed work, and shall not allow traffic or plant to pass over, nor use any part of partially completed work for storage or stockpiling of materials.

The contractor shall protect completed work from damage from whatever cause until handed over to the Client.

## **12. Testing**

The Contractor shall allow for all testing specified for workmanship and materials.

## **13. Testing Facilities**

The contractor shall submit details of all testing facilities, laboratories etc that he has available or proposes to provide for the performance of testing as required.

## **14. Drains and underground services**

All drains, services, cable ducts and other necessary work below formation level shall be completed and inspected and passed by the Engineer before the construction of any road or paved area is commenced.

The Contractor shall protect all service, ducts cables and pipes during construction of roads and paving and while the depth of cover over them is reduced. The Contractor shall submit a fully detailed plan for the Method of Protection.

## **15. Site Clearance and Earthworks**

### **15.1 General**

Notwithstanding any information contained within any report of a site investigation for this project the Contractor shall judge for himself the nature of the ground and shall be fully responsible for ascertaining all necessary information concerning permanent water table periods of rainfall flooding of the site and all matters affecting the excavations and foundation works.

The method of excavation which the contractor is adopting shall be at the sole discretion of the contractor. The use of explosives may be permitted only with the Engineer's written consent. The contractor shall take all necessary precautions to ensure the complete safety of all site personnel including any third party.

The Contractor shall obtain all necessary licenses and permission covering the purchase and use of explosives and shall meticulously observe the requirements of the relevant authorities.

No explosive shall be stored at the site at any time. The Contractor shall report to the Engineer when excavation are completed and are ready to receive new works and shall obtain consent before commencing the new works.

In the event of excavations being made larger than the size shown on the drawings or as otherwise directed by the Engineer the contractor shall at his own expense fill in the excavated void to the correct profile with suitable material as instructed by the Engineer.

### **15.2 Site Clearance**

A working strip over the width of the earthworks or as shown on the drawings or as instructed by the Engineer shall be cleared of all debris, bushes, fences and walls. Trees and saplings will be preserved and none shall be cut down without the prior approval of the Engineer.

Trees to be cut down shall be uprooted and the holes made by grubbing up removing roots, stumps and the like shall be back filled with suitable material and compacted in accordance with section 2 clause 17.

All materials arising from site clearance shall be disposed off site unless otherwise stated in the contract. Where material is taken off site it shall be disposed of in accordance with the requirements of the local Municipality and with the agreement of the Engineer.

### **15.3 Compaction of Existing Ground**

When the depth of material (including base) to be superimposed on the existing ground, other than in areas of rock, is less than 600mm, the contractor shall, before any fill is placed, scarify the existing ground and re-compacted in accordance with section 2 clause 17 over the full width of the embankment for a depth of at least 150mm.

### **15.4 Unsuitable Material below Formation Level**

Where unsuitable ground or other unsuitable material is found below formation level or the slopes of cuttings or under areas of fill this shall be excavated as shown on the drawings or as directed by the Engineer and the void back filled with suitable material compacted in accordance with Section 2- Clause 17. The unsuitable materials shall be removed to spoil.

## 16. Excavation of Cuttings

The contractor shall employ plant, which is suitable for the soils to be handled. He shall not at any time use any plant, which damages or reduces the natural strength of the soil either in its in-situ state or during handling and placing in its final compacted state.

Where the excavation reveals a combination of suitable and unsuitable material the contractor shall excavate the materials such that no contamination of the suitable material by the unsuitable material occurs.

Construction plant shall not use the surface of the bottom of a cutting unless the cutting is in rock or the contractor maintains the level at 300mm above formation level.

Hauling of material from cuttings or borrow pits to embankments or other areas of fill shall proceed only where sufficient and compaction plant are operating at the places of deposition.

## 17. Excavation of cuttings in Rock

'Rock' shall mean those geological strata or deposits so designated in the drawings and any hard natural or artificial material requiring the use of blasting or approved pneumatic tools for its removal but excluding individual masses less than 0.23m<sup>3</sup>.

## 18. Forming Embankments or other Areas of Fill

The Material for forming embankments shall be approved suitable material from cuttings or borrow pits or as specified in the contract. It shall have a minimum soaked CBR of 25% when compared to 95% of its maximum dry density to the modified AASHO compaction test. Where material from cuttings is encountered which would be suitable except that its CBR lies in the range of 10 – 24%, it may be incorporated in embankments at 500mm or more depth below formation level, subject to the approval of the engineer. All material shall be incorporated by an approval sequence of operations including the dumping of materials spreading watering mixing and compacting. The contractor shall keep the delays between consecutive operations to a minimum.

Any fill material used within 500mm of concrete structures shall have a soluble sulphate content not exceeding 2.5g per liter tested in accordance with test 10 of BS 1377, 1975.

Where rock is used in embankment it shall except for any specified external cover to slopes or near formation level, be of such size that it can be deposited in layers each not exceeding 450mm loose depth and extending over the full width of the embankment.

Material shall be spread or leveled by a crawler tractor weighting not less than 15 tonnes. Each layer shall be graded and all surface voids filled with broken fragments before the next layer is placed and compacted by at least 12 passes of a towed vibratory roller with a static mass per meter width of roll of at least 1800 kg or a grid roller with a mass per meter width of roll of at least 8000 kg or other approved plant. The top surface and side slopes shall be thoroughly blinded with approval fine graded material to seal the surface. In rockfill embankments the materials shall be carefully packed for such a distance from any structure as may be required by the Engineer.

### 19. Compaction of Earthworks

Suitable material shall be placed and compacted in layers not exceeding 200 mm in thickness over the full width of the formation. The Contractor shall route his compaction equipment in such a manner over the full width of the filling as to achieve a uniform compaction over the entire width by this method. All suitable material including subgrade and verges shall then be compacted to 95% of the maximum dry density obtained in the modified AASSHO compaction test.

Compaction shall be measured by expressing the dry density of the sample as a percentage of the maximum dry density at optimum moisture content for that material when compacted to the modified AASSHO test.

Compaction of all suitable material shall be carried out at moisture content between 1% above and 2% below the optimum for compaction. The Engineer may, however, direct that the moisture content at compaction be further controlled in order to reduce as far as possible any subsequent consolidation or swelling. Water shall be added as and where necessary by a water carrier fitted with an appropriate sprinkler and the uniform wetting of the layer to be compacted shall be achieved.

Test for the control of compaction shall be carried out at regular intervals as directed by the Engineer. If any test results from a particular area falls below the minimum specified then the contractor shall at his own expense scarify, water and re compact the area to the satisfaction of the Engineer.

The contractor shall allow in his construction Programme time for all necessary tests and for the results to be made known.

## **20. Preparation and surface Treatment of Formation**

The formation level shall be the level of the embankment or cutting in its final shape after completion of the earthworks and before the superimposition of the pavement construction. The formation shall be correct to line, level and cross fall. All earthworks shall be graded to provide the required information profile.

Before it is compacted the Engineer's Representative will inspect the formation and the contractor shall notify the Engineer's Requirement when each area of formation is ready for inspection and shall allow reasonable time for inspection to be made.

All loose pieces of stone or other material exceeding 75mm in any dimension shall be removed and disposed of as directed by the Engineer. The Contractor shall then compact the whole of the formation by the use of approved smooth wheeled or pneumatic rollers or vibratory compactors, but final compaction shall be by smooth roller. In cuttings, other than rock the formation shall be scarified to a depth of 150mm before compaction unless instructed otherwise by the Engineer.

## **21. Drainage, Flood Protection and Service Ducts:**

The excavation for culverts shall be to the levels and net widths required. Excavated material shall be hauled to areas of fill where suitable, or disposed off site where unsuitable for filling or surplus to requirements.

Culverts shall be pre-cast reinforced concrete pipes, boxes or in-situ concrete as shown on the drawings.

Culverts shall be cleaned out as necessary on completion. Inlets and outlets shall comprise reinforced concrete walls and aprons as shown on the drawings. The contractor shall submit his proposals for construction of the Inlets and Outlets to the Engineer for approval prior

## **22. Road Base**

### **22.1 Road Base Course**

Material for road base shall be obtained from approved borrow areas. Imported base material shall consist of naturally occurring gravel's, well graded, as approved by the Engineer. The maximum size of material shall not exceed 50mm and not more than 15% shall pass the 200 sieve. The 4 day soaked CBR at 100% modified AASHO compaction shall be not less than 80%. The fine material passing the 200 sieve shall have a plasticity index not exceeding 10% and a liquid limit not exceeding 30%.

### **22.2 Laying & Compaction of Road Base Material**

All material shall be placed and spread evenly. Compaction of the base material shall be carried out as soon as possible after the material has been laid. The material shall be compacted to 100% modified AASHO compaction at moisture content between 1% above and 2% below optimum. The compacted thickness of any layer shall not exceed 150mm.

The finished surface shall be left smooth and to a camber or cross fall as shown on the drawings, and shall be clean, free from compaction cracks, ridges or loose material. All loose or otherwise defective material shall be dug out and made good with new material to the required thickness and re-compacted at the contractor's expense.

Except there agreed by the Engineer, the completed base material must be protected from damage and must not be trafficked.

### **22.3 Compaction Equipment**

Smooth-wheeled and pneumatic roller and vibratory compactors or power rammers, where employed for compacting soils and pavement materials shall be of a type with compacting effort approved by the Engineer and shall be capable of achieving the specified degree of compaction. The distribution of wheels on any roller shall be such that the whole of the ground surface within the width of the roller is loaded during each pass of the roller.

### 23. Flexible Surfacing (Prime Coat)

The surface of the base material to be paved shall be free from loose or foreign material, slightly damped and free from standing water, after approval of the surface by the Engineer's Representative, it shall be dampened and primed with cut back asphalt type MC70 complying with the requirement of AASHO Specification M82 or equivalent at a rate of spread of 1.1 to 1.3 liters per square meter, at least 24 hours before surfacing or as specified by the Engineer.

### 24. Materials for Asphaltic Concrete Surfacing

#### 24.1 Aggregate

Coarse aggregate shall be hard, clean and durable crushed stone, crushed rock or crushed gravel from an approval source, with an Aggregate Crushing Value not more than 20% and shall be free from dirt and other deleterious material. Individual sizes of stone shall be combined from cold feed hoppers in suitable proportions to achieve the following:

Sieve Size	Percentage by weight Passing
20 mm	100
14 mm	85 - 100
10 mm	0 - 100
6.3 mm	0 - 60
2 mm	0 - 5

Fine aggregate shall consist of natural sand, sand prepared from stone, gravel or combinations thereof. It shall consist of hard, tough grains free from dirt and other deleterious material. The grading of fine aggregate shall comply with the following:

Sieve Size	Percentage by weight passing
5 mm	100
2 mm	85 - 100
600 mm	0 - 100
212 mm	0 - 60
63 mm	0 - 5

Mineral filler shall consist of finely ground particles of hydrated lime, Portland cement or other non-plastic mineral matter approved by the Engineer. It shall contain no organic impurities and be free from foreign or other deleterious material and shall meet the following grading.

Sieve Size	Percentage by weight Passing
600 micron	100
300 micron	95 - 100
75 micron	70 - 100

#### **24.2 Binder Course**

The binder shall be 60/70 Penetration straight run bitumen complying with AASHO designation M20.

The aggregate shall be combined to give a grading curve between the following limits:-  
Base Course (Nominal max. size 26.5 mm)

Aggregate Grading		% weight passing of total aggregate.
ASTM sieves	Aperture	
1.5"	37.5 mm	100
1"	26.5 mm	90 - 100
0.5"	13.2 mm	60 - 80
No. 4	4.75 mm	25 - 60
No. 8	2.36 mm	15 - 45
No. 50	300 micron	3 - 18
No. 200	75 micron	1 - 7

### 24.3 Wearing Course and Single course (Nominal max. size 19mm)

Aggregate Grading		% weight passing of total aggregate.
ASTM sieves	Aperture	
1"	26.5 mm	100
3/4"	19 mm	90 - 100
3/8"	9.5 mm	60 - 80
No. 4	4.75 mm	35 - 65
No. 8	2.36 mm	20 - 50
No. 50	300 micron	3 - 20
No. 200	75 micron	2 - 8

The nominal binder content shall be 4.2% for the base course and single course measured by weight of the total mix. The actual binder content to be used will be determined by the Engineer following approval of the contractor's mix design.

## 25. Asphaltic Concrete mix Design

### 25.1 General

The Contractor shall design the Asphaltic Concrete base course, wearing course and single course mixes in accordance with the Asphalt Institute procedure. The mixes shall be designed to ensure that in production the material can maintain compliance with the Marshall limits given below and such that the mixes are suitable for the use intended as road surfacing materials. The contractor shall give adequate notice in writing of any additional information he requires to complete his design mix.

The contractor shall submit to the Engineer for approval full details of his proposed aggregate grading and bitumen content together with details of the mix design.

When the design mix has been approved by the engineer, the contractor shall maintain the mix proportions as approved, within the following limits:

% by weight of	Total mix
Aggregate passing 5 mm sieve	3
Aggregate passing 1.18 mm sieve	2
Aggregate passing 63 mm sieve	1.5
Bitumen content	0.2

## 25.2 Marshall Mix Limits

The mixed materials in Asphaltic concrete shall comply at all times with the following requirements:-

Compaction number blows	Base Course	Wearing Course
Each end of Specimen	50	50
Marshall Stability (kg)	400 - 13000	400 - 1500
Flow Value (mm)	5 - 4.5	2 - 4.5
Voids in mixed aggregates %	14 - 18	16 - 19
Voids filled with bitumen %	57 - 83	69 - 85

## 26. Mixing and Laying Flexible Surfacing Materials

### 26.1 Mixing

Asphaltic concrete material shall be prepared in an approved central mixing plant of weight-batching type and shall be transported in clean vehicle, covered over whilst in transit or awaiting tipping.

The mixed material shall as soon as possible after arrival at the site be supplied continuously to the paver and laid without delay, the rate of delivery of material to the paver shall be so regulated as to enable the paver to be operated continuously and it shall be so operated whenever practicable. The materials shall be spread by approved mechanical asphalt pavers and compacted by rollers approved by the Engineer.

The rate of travel of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of material across the full laying width, freedom from dragging or tearing of the material and minimum segregation.

## 26.2 Laying

The material shall be laid generally in conformity with the recommendations for laying in the standard to which it has been made but in all cases subject also to the following additional overriding requirements.

Hand laying of any bituminous material will be permitted only in the following circumstances:

- For laying regulating course of irregular shape and varying thickness;
- In confined spaces where it is impracticable for a paver to operate;
- For footways

Material shall be compacted as soon as rolling can be effected without causing undue displacement of the mixed material and while this has at least the minimum rolling temperature applicable. The material shall be uniformly compacted by an 8-10 tonnes smooth-wheeled roller having a width of roll not less than 450mm or by a multi-wheeled pneumatic tyred roller of equivalent mass except that base course, wearing course and single course material shall be surface finished with a smooth-wheeled roller.

The material shall be rolled in a longitudinal direction from the sides to the centre of the carriageway overlapping on successive passes by at least half the width of the rear roller or in the case of a pneumatic-tyred roller, at least the nominal width of one tyre. Roller shall not stand on newly laid material while there is a risk that it will be deformed thereby.

Hand-racking of wearing course material which has been laid by a paver and the addition of such material by hand-spreading to the paved area for adjustment of level will be permitted only in the following circumstances.

- At the edges of the layers of material and at gullies and manholes.
- Where otherwise directed by the Engineer.

Hand laid work shall conform to all the specification requirements of this clause except those relating to the manner of operating pavers.

Where joints between laying widths or transverse joints have to be made in the wearing course, the material shall be fully compacted and the joint made flush in one or other of the following ways:

- a) This method is always used for transverse joints where applicable by heating the joint with an approved joint heater at the time when the additional width is being laid but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of the wearing course to a figure within the rolling temperature range specified for the material and for a width not less than 75mm on each side of the joint.
- b) By using two or more pavers where this is practicable and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling or by using a multiple-lane-width paver;
- c) By cutting back the exposed joints to a vertical face of not less than the specified thickness, discarding all loosened material and coating the vertical face completely with a grade of hot tar or hot bitumen suitable for the purpose before the next width is laid.

### **26.3 Temperatures**

Maximum temperature during mixing shall not exceed 170oC and at laying the temperature shall be in the range 120oC – 160oC.

The density of the completed asphaltic concrete layers shall be not less than 98% of the laboratory density of the approved Marshall mix design.

## **27. Surface**

### **27.1 Levels**

The levels of pavement course shall be determined from the true finished road surface calculated from the vertical profile and cross falls as shown on the drawings. The vertical depth below the true pavement surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated in the table below.

### Tolerances in Surface Levels of Pavement Courses and the Formation

Road Surface	± 6 mm
Base course	± 6 mm
Road Base	± 15 mm
Formation	± 6 mm

The surface level of the pavement at any point shall not deviate vertically from the true finished road surface by more than  $\pm 6$  mm. however, the combination of permitted tolerances in different pavement layers shall not result in reduction of the overall depth of wearing course and base course by more than 5 mm from that specified nor a reduction in the thickness of the whole pavement by more than 15 mm from the specified thickness. For checking compliance with these requirements, measurements of surface levels will be taken at points selected by the Engineer at 10 m centers longitudinally and at 2 m centre transversely. In any length of pavement, compliance with these requirements shall be regarded as met when not more than one measurement in any consecutive ten longitudinally or one in any transverse line, exceed the tolerances permitted, but this one measurement shall not exceed by more than 5 mm the tolerance for the layer concerned.

#### 27.2 Surface Regularity

The surface regularity shall be tested where necessary, at points decided by the Engineer, with a straight-edge 3m long placed parallel with or at right angles to the centre line of the road. The maximum allowable deviation of the surface below the straight-edge shall be:

For Road Surface	3 mm
For Base course Surface	6 mm
For Road base	10 mm

#### 27.3 Rectifications

Where any tolerances in this Clause are exceeded the contractor shall determine the full extent of the area which is out of tolerance and shall make good the surface of the pavement course or formation in the manner described below.

#### **27.4 Formation Level**

If the surface is too high it shall be re-trimmed and re-compacted to specification. If the surface is too low the deficiency shall be corrected by scarification and the addition of suitable material of the same classification and moisture content or other approved material laid and compacted to specification.

#### **28 Kerbs and Footways**

Precast concrete kerbs shall comply with BS 340 and shall be laid and bedded in a layer of cement mortar not less than 10 mm and not more than 40 mm thick, on concrete foundation.

#### **29 Concrete Pavements**

##### **29.1 General**

The Specification for Concrete Work associated with highway/concrete pavement areas shall be in accordance with section C concrete works supplemented by the clauses contained in this specification. Where any conflict arises between the specifications this specification shall apply for all concrete works associated with pavement construction.

##### **29.2 Waterproof Membrane**

An underlay as specified on the drawings shall be used to provide a waterproof/slip membrane between the concrete slab and the base course. Where an overlap of underlay material is necessary this shall be at least 300mm. Water shall not be allowed to pond on the membrane which shall be completely waterproof when the concrete is laid.

## 29.3 Joints

### 29.3.1 General

Joints shall be formed in a straight line and shall cross each other at right angles. Joints running in one particular direction shall be parallel to each other.

That part of the groove to be sealed whether wet formed or sawn after concreting shall be within a tolerance of 5 mm from a straight line along the length of the joint.

Joints shall be in the positions as shown on the drawings.

### 29.3.2 Expansion Joints

Expansion joints shall comprise vertical preformed joint filler, dowel bars and supporting cradles or assemblies and a groove as specified in the contract standard details drawings shall be located directly over the joint filler. Joint assemblies and filler boards shall be within a tolerance of  $\pm 5$ mm from the true line of the joint.

The joint filler is to be of sufficient rigidity to enable it to be satisfactory installed in the joint. It shall resist deformation during concreting and shall be installed with such accuracy that its upper surface lies within the width of the part of the groove to be sealed and such a depth below the surface as to allow the depth of seal. The joint filler together with the seal shall provide complete separation of adjacent slabs and any loose fitting holes around dowel bars and spaces between the sub-base and the filler board shall be packed with joint filler material after assembly of the joint.

Dowel bars shall be provided at mid-depth of the slab  $\pm 20$  mm. When supported in assemblies or cradles and positioned prior to concreting, the bars shall be parallel to the centre-line of the carriage way within the following tolerance:

All bars in a joint shall be within  $\pm 3$  mm per 300 mm length of bar, except that one bar in 3.65m may be outside this tolerance.

Two thirds of the bars shall be within  $\pm 2$  mm per 300 mm length of bar.

No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in any plane.

After concreting, the alignment of dowel bars shall remain within twice the above tolerances. Dowel bars shall be provided at one end with a closely fitting cap 100mm

long consisting of waterproofed cardboard or an approved synthetic material. An expansion space equal in thickness to that of the joint filler shall be formed at the end of the cap by inserting into it a joint filler. The cap shall be placed on the free half of each dowel which shall also be coated, within 14 days of concreting, with bond breaking compound.

The assembly of joint filler dowel bars and supporting cradles when fixed in position shall be rigidly fixed to the satisfaction of the Engineer.

### 29.3.3 Contraction Joints

Contraction joints shall comprise a bottom crack inducer, dowel bars and supporting cradles and a groove as specified in standard details drawings. The bottom crack inducer shall be an approved timber or synthetic strip or filler securely fixed to the surface underlying the slab along the line of the joint within a tolerance of  $\pm 5$  mm and cast into the

bottom of the slab. The dowel bars shall as specified in standard details drawing except that the caps shall be omitted. Cradles supporting dowels shall not be continuous across the centre line of the joint, and they must be fixed to the sub-base in such a way that the bars remain within tolerance after concreting.

The groove shall be located in the top of the slab vertically above the centre of the crack inducer to within a horizontal tolerances of  $\pm 13$  mm. The combined depth of the groove and the crack inducer shall be between one quarter and one third of the depth of the slab and the difference between the depth of the groove at the top and the height of the crack inducer at the bottom shall not be greater than 13 mm.

The crack inducer may be omitted if grooves are sawn. In these cases the depth of the groove shall be between one quarter and one third of the depth of the slab. The bars shall be at mid depth  $\pm 20$ mm, except where a deep groove between one quarter and one third of the depth of the slab is used, where the upper tolerance shall be only 10 mm.

As an alternative to positioning joint assemblies before concreting, dowel bars may be inserted into the plastic concrete by a method approved by the Engineer which ensures recompaction around the bars. The insertion of the bars shall be carried out before the passage of the final finishing beam or screed. Inserted contraction joint dowel bars shall be equally positioned about the centre line of the joint within a tolerance of  $\pm 50$  mm.

### 29.3.4 Longitudinal Joints

Longitudinal joints in concrete paved areas shall be positioned as shown on the drawing and shall have dowel bars fully or partly bonded as specified. On concrete roads

longitudinal joints shall be provided at the edge of each traffic lane within the tolerances given in the contract, except when:

- a) Reinforced 3 lane carriage ways are constructed in two slab widths, as described in this clause.
- b) A hard strip adjoins a traffic lane and is constructed in one operation with that lane, to the full thickness of the carriage ways and providing the maximum width of the slab does not exceed 4.8m.
- c) At right angles to the line of each longitudinal joint, tie bars shall be placed or inserted and the joint sealant shall be 12mm diameter. 1.0m long mild steel or 10mm diameter, 750mm long high yield deformed bars. They shall be placed parallel to surface profile within the middle third of the slab thickness.

When pavement are constructed in more than one lane width shall be an approved timber or synthetic strip or filler shall be securely fixed to the surface underlying the slab along the line of the joint within a horizontal tolerance of  $\pm 5$ mm, and cast into the bottom of the slab. A groove shall be made in the top of the slab, and be located vertically above the centre of the filler to within a horizontal tolerance of  $\pm 13$ mm. It shall not deviate from the general line of the joint as laid by more than 5mm. The combined depth of the groove and the crack inducer shall be between one quarter and one third of the depth of the slab and the difference between the depth of the groove at the top and the height of the crack inducer at the bottom shall not be greater than 13mm. The crack inducer shall be omitted if grooves are sawn. In this case the depth of the groove shall be between one quarter and one third of the depth of the slab, but the top of the tie bar must be at least 20mm below the bottom of the groove.

### 29.3.5 Construction Joints

Emergency joints in reinforced concrete pavement shall only be installed in the event of mechanical breakdown or adverse weather and shall not be constructed less than 3m from any expansion or construction joint. They shall be formed by means of drilled and split cross form in which tie bars 12mm diameters 1.0m long at 600mm centre at mid-depth of the slab shall be inserted and which shall permit the reinforcement to project through the joint for a distance of at least 600mm the next reinforcement shall completely overlap and be tied to the projecting reinforcement.

### **29.3.7 Sealing of Joints**

Before any traffic is permitted to use the pavement in advance of permanent sealing, the joint immediately prior to permanent sealing, shall be cleaned and any direct or loose material or any temporary sealing former or other filling material shall be removed. The sides of the part of the groove to be sealed shall be scoured by either grinding, sawing or dry sand-blasting except where plastic formers are used. The groove shall be temporarily caulked prior to sandblasting. In addition or for the removal of old sealing compound, high pressure water jetting or water-and sand blasting may be used. The surface of the groove shall be dry at the time of sealing. The dimensions of the seals shall be in accordance with Contract Standard Details if the depth of the groove exceeds the depth of the seal the groove may be caulked to the required depth with a compressible caulking material of a type which does not affect and is not affected by the sealing compound to be used. Compressible filler shall be used in all grooves with polysulphide type sealant so that the width/depth ratio of the seal shall be between 2:1 and 1:1. Any spillage at the edges of the grooves shall be made good to the satisfaction of the Engineer, using an approved material compatible with the sealant, before the sealant is applied.

The prepared groove shall then be sealed with poured compounds. Where recommended by the manufacturer of the sealing compound, an appropriate primer shall be used in accordance with the manufacturer's recommendations.

Two component cold poured sealants shall be thoroughly mixed in the correct proportions in accordance with the manufacturer's instructions using an automatic mixer dispenser approved by the Engineer, or for small quantities for hand application, using a power operated mixer for sufficient time to produce a homogeneous mix. As soon as possible after mixing, the material shall be poured into the joint or applied using a caulking gun, to a level between 3 mm and 6 mm below the concrete surface. The tack-free time shall be achieved within 3 hours for machine-applied material or 12 hours for hand-applied sealants.

Expansion joint filler shall normally be 25mm thick.

### **30. Treatments at Manholes and Gullies**

Manhole covers, gullies and their frames shall be isolated from the main pavement slab and be housed in n separate slabs. The slabs shall be larger than the exterior of the manhole shafts and any concrete surround if the top of the shaft is less than 150 mm below the bottom of the concrete pavement.

The positions of manholes, gullies and joints in the concrete pavement shall be adjusted related to each other so that the manhole and gully slabs shall be adjacent to a joint or the edge of the slab, or alternatively lie within the middle third of the slab. When this is not possible, reinforcement must be included around the gully or manhole recess.

Manholes and gully recesses shall be formed by casting the main slab against form work boxes places and fixed accurately and vertically. The form work shall be removed where the concrete around the manhole or gully cover is to be placed and performed joint filler 20mm thick fixed to the slab edges so exposed. This shall be the full depth of the slab allowing for the depth of the groove required for sealing. Alternatively the recess may be sawn out after the concrete has hardened.

A groove for a seal shall be made directly above the performed joint filler and sealed as specified above.

Reinforcement as described in the contract shall be placed in the position shown and concrete placed by hand in the space between the main slab and the manhole frame. This concrete shall meet the strength requirements specified on the drawing and the mix shall be modified to permit full compaction by the methods adopted.

### **31. Concrete Mixes:**

Refer to section 3 Concrete works Specification.

### **32. Mixing Concrete**

Refer to section 3 Concrete works Specification.

### 33. Transport & Placing

Refer to section 3 Concrete works Specification.

### 34. Compacting & finishing and surface treatment

Concrete shall be evenly placed without pre-compaction or segregation and be compacted in the following manner.

a) Concrete to be compacted by a vibrating beam shall be struck off at such a level than the surface level after all entrapped air has been removed by compaction is above that of the side forms. The concrete shall be compacted by a steel-shod hardwood compacting beam, the beam being lifted and moved forward by increments not exceeding the beam width.

Alternatively, a vibrating twin beam compactor of equivalent power may be used. After every 1.5m length of slab has been compacted the vibrating beam shall be taken back 1.5m and then drawn slowly forward whilst vibrating over the compacted surface to provide a smooth finish.

The surface shall then be regulated by at least two passes of a scraping straight edge with blade length not less than 1.8m. If the surface is torn extensively by the surface a further pass of the scraping straight-edge.

b) Surface Finish during Initial Construction of Concrete Pavement:

After the completion of joints and the final pass of the finishing beam and before the application of the curing membrane, the surface of concrete pavements to be used as running surface shall be brushed in a direction at right angles to the centre line of the pavements.

Brushed finish shall be formed with a wire e broom not less than 450mm wide. The wire tufts of the broom used shall initially be 100mm long of 32 gauge tape wire. The broom shall contain two rows of tufts, at 20 mm centers and tufts shall be at 10 mm centers and offset to the centre of the gap between tufts in the other row. The tufts shall average 14 wires each. Brooms shall be replaced when shortest tufts wear down to 90mm long.

### **35. Curing**

The exposed surface of concrete pavements shall be cured immediately after the surface treatment specified in Clause 32 by treating with an approved curing compound as. It shall be mechanically sprayed on to the surface at the rate of 0.22 – 0.27 l/m<sup>2</sup> using a fine spray. For the sides of slabs when the side forms are removed within 24 hours and for small areas where a mechanical distributor cannot be used, the compound areas shall be sprayed by hand lance at the rate of 0.27 to 0.36 l/m<sup>2</sup>. Any groove over a joint shall be protected from entry of curing compound.

The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound in its container during spraying.

### **36. Aggregates for Concrete**

Refer to section 3 Concrete works Specification.

### **37. Bond Breaking Coating for Dowel Bars**

Bond breaking compound shall be an approved compound which shall not retard or in any other way affect the setting of concrete.

The average bond stress on bars coated with the compound for concrete specimens and subjected to pull out tests at 7 days shall not exceed 0.14N/mm<sup>2</sup> and the total movement of the dowel bars relative to the concrete shall be not less than 0.25mm at the stress. The concrete specimens shall be 150mm x 150mm in section and 450mm long and made with the same mix proportions as used in the works.

### **38. Cement**

Refer to section 3 Concrete works Specification.

### **39. Dowel Bars and Tie Bars for Concrete Pavements**

Dowel bars shall consist of mild steel and tie bars shall be of mild steel or deformed bars of high yield steel complying with the requirements of BS 4449 and they shall be free from oil, paint other than bond breaking compound, dirt, loose rust and scale.

Dowel bars for joints shall be straight free from burred edges or other irregularities and shall have their sliding ends sawn or if approved by the Engineer sheared

#### **40. Cold Poured Joint Sealants and Seals**

Joint Sealants shall consist of cold poured compounds as described in the contract and which comply with the following Clauses:

Cold-poured sealants for joints in pavements and footways shall comply with the performance requirements of the Normal type of sealant.

The sealant shall be composed of curing agent and a base resin, which shall be in such proportions as recommended by the manufacturer to provide a fast cure if the material is mixed and applied by special machines, or a retarded cure if mixed by hand. When a primer is recommended by the manufacturer it shall be applied within the temperature range of 10 deg. C and 40 deg. C it shall cure within one hour and remain active for not less than 4 hours. The sealant shall be applied after the curing period of the primer and within the period that the primer remains active.

Material mixed and applied by hand shall be supplied in separate containers in the correct proportions and shall be mixed using a powered stirrer or mixer or any other method approved by the Engineer.

#### **41. Preformed Joint Filler**

Preformed joint filler shall be compressible filler board consisting of wood fibres impregnated with a bitumen emulsion.

#### **42. Steel Reinforcement**

Refer to the section 3 Concrete works Specification.

an approved mix design and an approved method of replacement.