

PROJECT SPECIFICATION

Paving a local road in Salahuddin and Bab Tripoli area, Abu Salim Municipality, Libya

Issued for Tender only



UNDP Libya

2019

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PRELIMINARY AND SITE FACILITIES

General Requirements and Provisions

Scope

This Section covers matters which relate to the construction work as a whole.

Programme of Work

The programme of work required in terms of the General Conditions of Contract shall be submitted to the Engineer not later than 14 days after the Contractor has been issued with the order to commence.

The Programme shall not be in the form of a bar chart only, but shall show clearly the anticipated quantities of work to be performed each week/month, (Construction Planning) the resources to be applied to each activity, as well as the anticipated earnings for the various sections of work. If, during the progress of the work, the quantities of work performed per week/month fall below those shown in the programme, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Contractor shall, within one week after being notified by the Engineer, submit a revised programme.

If the programme is to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing the modifications to the original programme necessary to ensure completion of the works or any part thereof within the time for completion or any extended time granted as per the Conditions of Contract.

Any proposal to increase the tempo of the work must be accompanied by positive steps to increase production by providing more labour and plant on Site, or by using the available labour and plant in a more efficient manner. Failure on the part of the Contractor to work according to the programme or revised programme shall be sufficient reason for the Employer to take steps as provided for in the Conditions of Contract and shall be construed as not executing the Works in accordance with the Contract.

The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer would be satisfied if the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme, nor shall it limit the right of the Engineer to instruct the Contractor to vary the programme should circumstances make this necessary.

The above shall not be taken to limit the right of the Contractor to claim for damages or extension of time to which he may be fairly entitled to in terms of the General Conditions of Contract for delay or disruption of his activities. Should the Employer request and the Contractor undertake to finish the whole or part of the Works ahead of the time originally required by the Contract, payment for accelerating the work shall only be made if agreed to beforehand in writing and according to the terms of such agreement.

Workmanship and Quality Control

The onus is on the Contractor to produce work which conforms in quality and accuracy of detail to the requirements of the Specifications and/or Drawings, and the Contractor must, at his own expense, institute a quality control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

The cost of all supervision and process control, including testing, so carried out by the Contractor, shall be deemed to be included in the rates tendered for the related items of work except that the cost of certain tests and the provision of certain items of testing and sampling equipment will be paid for separately as provided for in those Sections of the Specifications where this applies.

Unless otherwise instructed by the Engineer, the Contractor shall obtain approval for each layer of the works, in embankments, sub-grade, or any gravel or pavement layers and shall not proceed with subsequent layers until each approval is granted. The Contractor shall be required to give reasonable notice to the Engineer to allow any inspection to be carried out. If any test is required to verify compliance with these specifications, then the Contractor shall plan his Works so as to allow the Engineer sufficient time to carry out such tests. Unless instructed otherwise, the Contractor may proceed with the Works even though the results of tests may not yet be available. However, the Contractor shall be required to re-execute work if tests indicate non-compliance with these Specifications. Any approval given by the Engineer shall not relieve the Contractor of any of his obligations under the Contract.

Measurement and Payment

Bill of Quantities

The quantities set out in the Bill of Quantities are estimated quantities and are used for the comparison of Tenders and awarding the Contract. It must be clearly understood that only the actual quantities of work done or materials supplied will be measured for payment, and that the billed quantities may be increased or decreased as provided for by the General Conditions of Contract.

Contract Rates

In computing the final contract amount, payments shall be based on actual quantities only of authorized work done in accordance with the Specifications and/or Drawings. The tendered rates shall apply, subject to the provisions of the General Conditions of Contract, irrespective of whether the actual quantities are more or less than the billed quantities.

The Contractor shall accept the payment provided in the Contract and represented by the prices tendered by him in the Bill of Quantities, as payment in full for executing and completing the work as specified, for procuring and furnishing all materials, labour, supervision, plant, tools and equipment, for wastage, transport, loading and offloading, handling, maintenance, temporary work, testing, quality control including process control, overheads, profit, risk and other obligations and for all other incidentals necessary for the completion of the work and maintenance during the Period of Maintenance.

In particular the Contractor shall be deemed to have included time related and fixed costs under the appropriate items in the General and Preliminary Section of the Bill of Quantities and not in rates for work items.

Pay items

The descriptions under the pay items in the various Sections of the Specifications, indicating the work to be allowed for in the tendered prices for such pay items, are for the guidance of the Contractor and do not necessarily repeat all the details of work and materials required by and described in the Specifications. These descriptions shall be read in conjunction with the relevant Specifications and/or Drawings and the Contractor shall, when tendering, allow for his prices to be inclusive as indicated above.

Substantial Completion of the Works

The Contractor shall note that the Engineer reserves the right not to certify the Works to be “substantially completed” as required by the General Conditions of the Contract, unless the following portions of the Works are completed according to the Specifications:

- (a) All bituminous seal works or, where a seal is not included, the uppermost gravel layer.

(b) All drains and drainage structures, for the construction of which timeous instructions were given by the Engineer.

(c) Finishing of all support or retaining structures.

Opening of individual sections or lots shall not entitle the Contractor to receive a Completion Certificate.

Protection of the Works and Requirements to be met before Construction of New Work on top of Completed Work is Commenced

The Contractor is to provide temporary drainage works such as drains, open channels, banks, etc. and furnish and operate temporary pumps and such other equipment as may be necessary to adequately protect, drain and dewater the works and temporary works. This will be in addition to any permanent drainage works specifically paid for separately. Care shall be exercised to keep all completed layers properly drained, not to cause dumps of material on completed layer work to inhibit surface drainage or to form wet spots under and around dumps, and to protect all parts of the work against erosion by floods and rain.

Material shall not be spread on a layer that is so wet such as to damage underlying layers or prevent adequate compaction of overlying layers. Such wet layers shall be dried and recompact or removed. Excavations for pipe drains, culverts, sewer drains, water mains, manholes, service ducts and similar structures shall be adequately protected against the possible ingress of water during rainstorms.

All completed layer work shall be protected and maintained until the following layer is applied. Maintenance shall include immediate repairs to any damage or defects which may occur and shall be repeated as often as is necessary to keep the layer continuously intact and in a good condition. Before any completed layer is primed or a succeeding layer constructed thereon, any damage to the existing layer shall be repaired so that after repair or reconstruction if necessary, it will conform in all respects to the requirements specified for that layer.

All repair work other than minor surface damage repairs shall be submitted to the Engineer before covering up.

Work performed as part of the above obligations shall not be measured and paid for separately and the cost thereof is to be included in the prices tendered for the various items of work requiring protection and for the Contractor's establishment on Site.

Remedial Work

When any part of the Works or any equipment or material is found upon examination by the Engineer not to conform to the requirements or is at any stage before final acceptance damaged so that it no longer conforms to the requirements of the Specifications, the Engineer may order its complete removal and replacement, at the Contractor's expense, with satisfactory work, equipment or material or he may permit the Contractor to apply remedial measures in order to make good any such defects or damage. The actual remedial measures taken shall at all times be entirely at the Contractor's own initiative, risk and cost, but subject to the Engineer's approval regarding the details thereof.

In particular, remedial measures shall ensure full compliance with the Specifications of the final product, shall not endanger or damage any other part of the Works and shall be carefully controlled

Sign Boards

The Contractor shall provide identification sign boards. A signboard is to be erected at each end of the works and maintain them in good condition. All information on the signboards will be written in English and Arabic. The signboards will be positioned as directed by the Engineer. The Contractor shall submit proposals for the materials of the signboards, the text layout and installation of the signboards on Site to the Engineer for approval.

Name and Number of Contract

Name of Employer and Employer's Agent

Length of Works

Cost of Works

Date of Commencement and Completion.

Payments and Tolerances

The work specified in the various sections of these Specifications shall comply with the various dimensional and other tolerances specified in each case. Where no tolerances are specified, the standard of workmanship shall be in accordance with normal good practice.

Where the work is not as constructed provided that the dimensions are not so far below the minimum specified that in the Opinion of the Engineer they will not function adequately with the "authorized" dimensions, plus or minus any tolerances allowed, the engineer may nevertheless in his sole discretion accept the work for payment. In such cases no payment will be made in respect of quantities of work or material in excess of those calculated from the "authorized" dimensions and where the actual dimensions are less than the "authorized" dimensions, minus any tolerance allowed, quantities for payment shall be based on the actual dimensions as constructed

Photographic Records

The Engineer shall make photographs and other records to be agreed with the Contractor of the condition of the surfaces of the site immediately before entering upon them for the purpose of constructing the Works. Each month, the Contractor shall make a set of up to 100 digital colour photographs illustrating progress of the Works, or any other photograph that he may deem necessary for record purposes, and provide these to the Engineer for his records. The copyright of all photographs shall be vested in the Employer and the Contractor shall not use any photograph for any purpose whatsoever without the Engineer's approval.

Access to Site

Where the access to the Site proposed to be used by the Contractor lies across the land of any third party the Contractor shall produce to the Engineer the written consent of the owner and the occupier of the land over which the access lies before making use of the same.

The Contractor shall also make a record to be agreed by the Engineer of the conditions of the surfaces of any land (and of any crops on such land) over which access lies before he uses it for access purposes and he shall keep all such surfaces in a reasonable state

of repair during the executing of the Works. On the termination of the Contractor's use of such access he shall restore any lands, roads or other property to a condition at least equal to that existing before his first entry upon them

Security of the Works

Watching of the Works shall be provided by the Contractor at his own expense. If the Engineer considers it necessary, he will order in writing that additional watchmen be provided all at the Contractor's expense.

Suppression of Noise

The Contractor shall make every reasonable endeavor both by means of temporary works and by the use of appropriate plant or silencing devices to ensure that the level of noise resulting from the execution of the Works does not constitute a nuisance.

Safety

The Engineer shall be notified by the Contractor immediately any accident occurs whether on Site or off Site in which the Contractor is directly involved which results in any injury to any person whether directly concerned with the Site or whether a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

Transportation of any material by the Contractor shall be in suitable vehicles which when loaded do not cause spillage and all loads shall be suitably secured. Any vehicle which does not comply with this requirement or any of the local traffic regulations and laws shall be removed from the Site.

Work Methodology

The Contractor shall submit work methodology for his whole work for the prior approval from the Engineer and adopt a method of working such as to permit the satisfactory and timely completion of the Works and to limit disturbance and damage to a minimum.

The Contractor shall only open up sections of the Works for which his resources are sufficient to maintain continuous and methodical progress. If in the opinion of the Engineer, the Contractor has not complied with the foregoing, he shall be entitled to suspend sections of the works as per the General Conditions of Contract until other sections have been completed to a stage where risk of damage through exposure to traffic and the elements and inconvenience to public traffic has been minimized.

Constructional Plant used in the execution of the Works shall be of a design and used in a manner approved by the Engineer. The Engineer may at any time withdraw his approval for any method of working proposed by the Contractor and the Contractor shall immediately adopt another method of Working. If such change shall be required to achieve satisfactory progress or workmanship, the Contractor shall have no claim against the Employer for costs incurred by him in changing the method of working or in the provision and use of other plant.

Temporary Works

The Contractor shall provide, maintain and remove on completion of the Works all temporary works necessary for the construction of this permanent works. All temporary works shall be properly designed and constructed to carry such loads as may be imposed upon them and shall be safe and suitable in every respect for providing access or carrying plant or for the construction of the Works or other purposes.

Provision for Traffic

The Contractor shall at all times provide for traffic flow along existing roads, rivers and canals. The Contractor shall provide and maintain all detours, temporary roads, temporary bridges, necessary barricades, warning lights and guide signs as well as other equipment at all hours during the day or night.

The Contractor shall in due time and at least one month before any diversion of traffic, submit a detailed stage programme for the Engineer's approval. The programme shall show all arrangements necessary to ensure a smooth traffic flow. Upon completion of the Works, all temporary roads, temporary bridges, barricades, signs and other equipment shall be completely removed, unless otherwise approved in writing by the Engineer.

The Contractor shall so plan his operation so as to maintain the flow of traffic through the Works without disruption or delay. Road closures may be permitted by the Engineer in exceptional circumstances. The Contractor shall give at least 7 days notice of any proposed road closure. Upon completion of a days work, or if the Works are to be left unattended, the Contractor shall leave the Works in such a condition so as to allow the safe passage of traffic.

The Contractor shall be responsible for complying with all regulations relating to the temporary closure of roads in Libya. Should the road width be restricted or should there be any form of obstruction or danger to traffic, the Contractor shall supply adequate flagmen, signs, barriers, lights, communications and staff to ensure that the traffic is safely conducted through the Works.

Testing of Materials

Contractor's Site Laboratory

The Contractor shall provide and maintain minimum facilities of a site laboratory for the use of the Contractor and the Engineer including furniture, testing equipment and consumable stores necessary to carry out the tests listed below. The laboratory shall be constructed with a concrete floor and brick walls, shall be watertight and provided with electricity, potable running water and sewerage.

Where necessary independent testing will be undertaken at a laboratory specified by the Engineer for which a provisional Sum is included in the bill of quantities.

The list of the test furnished below may include but not be limited to those required for.

Soil

Classification (Grading, Atterberg limits), Compaction, (AASHTO T180), density, moisture contents, dry density, DCP

Aggregate (Coarse & fine)

Grading (Fineness modulus), Flakiness, density, moisture content,

Cement

Setting time, mortar cube strength

Concrete

Slump

Bricks

Absorption, Unit weight

Bituminous mixture

Temperature, combined gradation.

Pavement Layers

surface tolerance and thickness checking

Pavement Surface

Roughness

Materials Testing by Independent Laboratories

In addition to the Site testing facilities described in Specification Section, the Contractor shall be responsible for arranging for the field and off-Site laboratory tests listed and all other tests indicated as the responsibility of the Contractor to be performed by testing laboratories approved by the Engineer. The Contractor shall be responsible for all attendance on staff from these approved testing laboratories, including if necessary, the provision of transport for personnel, equipment and test specimens.

Special and Additional Testing

In addition to the testing described in Specifications here, the Engineer may require further testing to be carried out. Such special and additional testing shall be arranged by the Contractor at approved laboratory at Afghanistan or out-side abroad under the direction of the Engineer.

Staff for Materials Testing

The Contractor shall provide qualified laboratory engineers, technicians, assistants, labourers, etc. to carry out sampling and testing of materials.

Test Results and Records

The Contractor shall maintain complete records of test results which may be inspected by the Engineer at any time. All test results shall be recorded on standard forms approved by the Engineer and shall be signed by the Contractor's engineer or technician in charge of the laboratory. Completed forms shall clearly show the locations of samples, sampling dates and testing dates. Samples shall be numbered serially at the time of sampling. The Engineer may witness any sampling or testing carried out in the laboratory and will have the right to use the facilities and equipment to make his own tests. The Contractor shall have the right to witness any sampling or testing carried out by the Engineer. On completion of the contract the original copies of all tests results shall be handed over the Employer, via the Engineer. All tests results should be submitted to the Engineer immediately after the test.

Measurement and Payment

The provision of the laboratory, Materials Engineers office, furniture, equipment and the removal from Site of the laboratory, Materials Engineers office, furniture and equipment at the end of the Contract shall be paid for at a lump sum price. Maintenance of the site laboratory, Materials Engineers office, furniture and equipment shall be deemed in unite rate item wise.

Approval of Sources of Materials

The sources of the materials shall be selected by the Contractor but approved by the Engineer prior to their incorporation in the Works. For this purpose, the Contractor shall furnish all relevant test data for representative samples from each source area as desired by the Engineer and also afford opportunities for the Engineer to visit the source areas. The number of representative samples to be tested shall not be less than two for each type of material in each source area. Notwithstanding approval of sources of materials, materials as brought to the work site for use in the work shall be subject to acceptance or rejection by the Engineer based on quality control tests to be performed before use in construction.

Stockpiling of Materials

All materials brought to the site shall be stockpiled and stored in a systematic manner so as to prevent deterioration or mixing of materials or intrusion of foreign matter. Preparation and storage of materials along the alignment will not be allowed. The Contractor shall make all arrangements and bear all costs associated with the provision of these storage areas.

The site of stockpile shall be cleared of vegetation and debris, graded and drained. The bottom 50mm layer of aggregate or any contaminated aggregate shall not be used in the work. Materials which have suffered intrusion and deterioration due to improper storage shall not be used in the works.

Control Tests on Material Stockpiles

The Contractor shall use only such materials in construction as conform to the requirements regarding composition, grading, and physical properties and engineering characteristics specified for different kinds of material. For this purpose pre-construction control tests shall be carried out on representative samples collected at random from material brought to the site or at stockpiles. Any stockpile or any material brought to the site found not conforming to the Specification requirements shall be removed promptly.

Compaction Equipment

Mechanical equipment shall be used for compacting materials by rolling, tamping and watering (if needed).

For other

Operations such as spreading, mixing and shaping, manually operated tools and equipment is preferred on mechanical equipment alone or a combination of the two shall be used. The choice of equipment and the procedure for their use shall be subject to the approval of the Engineer upon his being satisfied about their effectiveness on the basis of trial compaction.

It shall be understood by the Contractor that different types of material are likely to require different kinds of compaction equipment, including successive applications thereof, to achieve the specified degrees of compaction, and the Contractor shall keep available compaction equipment of the requisite kind, size and number.

For compacting narrow strips and for compaction in restricted areas smaller sized compacting equipment may be required and if so, the same shall be provided for by the Contractor.

Compaction

Compaction of materials shall be done in layers of uniform thickness using approved compaction equipment including combinations thereof if desired by the Engineer.

Compaction with rollers shall commence at the edges and progress towards the centre except in superelevated and other stretches of unidirectional cross fall, where the rolling shall commence at the lower edge and progress towards the upper edge. When commencing rolling from an edge, rollers shall run forward and backward along the edge several times till the edge strip becomes firm to provide lateral support. The roller shall then move inwards parallel to the centre line of the road in successive passes with the tracks made by successive passes overlapping. Rolling shall continue till the specified degree of compaction is achieved throughout. When rolling is terminated at an edge, the procedure similar to that for commencing rolling at an edge shall be adopted. During rolling, the top of the layer being rolled shall be checked for levels and cross fall and any irregularities in these regards corrected by loosening the material in the affected area and by removing or adding materials and continuing with the rolling until the entire area being rolled has been brought to a state of uniform and desired compaction.

Compaction Trials

To demonstrate the efficiency of mixing and compaction equipment and the working methods proposed to be used by the Contractor for different kinds of materials, the Contractor may be required to carry out compaction trials before starting full-scale construction on the road. Based on results of compaction trials and construction observations, the Engineer may direct the use of particular mixing and compaction equipment and methods and disallow the use of others.

Compaction Control

After the compaction of each layer of material, field density tests shall be done on the compacted material. For locating test points, successive compaction panels covering the entire area of work shall be designated in advance of compaction. The frequency of the tests (in terms of square metres of compacted area of each layer for which minimum one test is to be done) shall be separately specified for different kinds of material. The test locations shall be chosen through random sampling techniques.

For material other than bituminous mixes, the compaction panels in which the compaction work is found as non-acceptable shall be given re-compaction accompanied with scarifying and wetting/drying for the entire thickness of the compacted layer to achieve the specified degree of compaction. In case of bituminous mixes, the compaction panels in which the compaction work is found as non-acceptable shall be stripped off and re-laid with fresh bituminous mix and re-compacted.

Mixing and Control of Moisture Content

Before compaction is taken up (other than for bituminous mixes), each layer of material shall be brought to a state of uniform composition, texture and moisture content by thorough mixing and addition of water or drying as required. The Contractor shall be deemed to have taken account of the fact that the materials encountered may vary widely with respect to their in-situ moisture content and the moisture content at which the materials are to be compacted.

Drainage during Construction

All embankment, sub-grade, shoulder and pavement layers under construction shall be protected from any accumulation of water due to rains or other causes and from erosion. All such layers under construction shall be provided with cross-fall to facilitate surface run-off and, if necessary, the cross-fall shall be supplemented with temporary drains or pumping arrangements to prevent accumulation of water.

Protection to Existing Embankment/Pavement Layers

Excavation for new construction, and placement of materials and their in-situ processing and compaction shall be done in such a manner and with such precautions as not to cause any damage to embankments, sub-grade layers, shoulders and pavement layers in position including those pre-existing and intended to form part of the improved road.

Disposal of Hauling Equipment

Hauling equipment bringing materials to the site of work shall be dispersed uniformly over the surface of the previously constructed layers in order to avoid rutting and uneven compaction. The materials from hauling equipment shall not be dumped in concentrated heaps but deposited as evenly distributed layers.

Plying of Traffic

Layers of embankment, sub-grade, pavement and shoulder during construction shall be protected against the plying of any kind of traffic other than construction equipment, till the new construction has been finally opened to traffic.

Drawings

The drawings referred to in the contract document are the standard cross sections of the road.

Typical Cross Section given in the drawings are provided as a guide only. The locations and extent of works to be undertaken will be ordered by the Engineer on site.

BITUMINOUS PAVEMENT

GENERAL

Materials

All materials shall be tested by the Contractor in the presence of the Engineer's representative at the Site except where manufacturer's test certificates are supplied and accepted.

Unless otherwise specified, all tests shall be carried out in accordance with the Standard Laboratory Test Procedures for Quality Control. If the quality of the sample from any stockpile or consignment after test is found to be inferior to that required by the specifications the material of that consignment will not be accepted and the Contractor shall remove such rejected materials from site.

The Contractor may arrange for testing to be carried out at his own cost prior to delivery of materials to site but this shall in no way affect the Engineer's right to carry out tests and reject defective materials at the Works.

Bituminous Materials

a) Penetration Grade Bitumen

Sampling:

Bitumen shall be sampled in accordance with AASHTO T40. Samples thus sampled will be tested for penetration, specific gravity, softening point, loss on heating, flash point and solubility.

Packing:

Bitumen shall be supplied in bulk in appropriate road tankers or be packed in securely sealed brand new steel drums.

Penetration:

The penetration shall be not less than 80 and not more than 100, or as otherwise directed by the Engineer. Penetration shall be determined in accordance with AASHTO T49 at 25°C.

Specific Gravity:

Specific gravity shall be determined in accordance with AASHTO T228.

Specific gravity at 25°C shall be not less than 1.00 and not more than 1.05.

Softening Point:

Softening point shall be determined in accordance with AASHTO T53.

The softening point shall be not less than 43°C and not more than 54°C.

Loss on Heating:

Loss on heating shall be determined in accordance with AASHTO T47.

Loss on heating shall not exceed 1%.

Flash Point:

Flash point shall be determined in accordance with Cleveland Open Cup method AASHTO T48.

The flash point shall be not less than 230°C.

Solubility:

Solubility shall be determined in accordance with AASHTO T44.

The solubility shall be not less than 99.0%.

General Requirements:

The bitumen shall be homogeneous, free from water and shall not foam when heated to 180°C.

b) Bitumen Emulsion

General:

Bitumen emulsion shall be a mixture of penetration grade bitumen, water and an emulsifying agent.

Bitumen emulsion deteriorates on storage and always should be used as soon as possible after manufacture.

Drums should be rolled for several minutes before use to remove any sediment. Testing generally should be in accordance with AASHTO T59.

Sampling:

Bitumen emulsion shall be sampled shortly before use, sampling shall be in accordance with AASHTO T40. Samples thus sampled shall be tested for bitumen content, viscosity, residue on sieving etc.

Packing:

Bitumen emulsion shall be packed in clean steel drums of the type and quality used for fuel oil deliveries.

Drums shall be fitted with a watertight screwed stopper.

Bitumen Content:

The percentage of bitumen by weight retained after distillation in accordance with BS434 Appendix-E shall be not less than 57%.

Viscosity:

The viscosity of the bitumen emulsion shall be between 6 and 9 degrees Engler at 20°C as determined in accordance with BS434.

Residue:

The percentage of residue by weight as determined in accordance with BS434 shall not be greater than 0.05% on the 0.710 mm sieve or 0.15% on the 0.150 mm sieve.

Coagulation:

There shall be no coagulation of the emulsion at low temperature as determined in accordance with BS434

Cut-back Bitumen

General:

Cut-back bitumen is a mixture of penetration grade bitumen and kerosene.

Cut-back bitumen is not manufactured commercially in Libya at the present time but may be mixed on site for immediate use. The Engineer will direct the mix proportions to be adopted for a particular application but the following will indicate the range of likely mixtures.

Grades (a) Fluid - 80/100 bitumen mixed with 20% - 40% kerosene by volume.

(b) Medium - 80/100 bitumen mixed with 10% kerosene by volume. (Suitable for use in penetration grouting etc.) (

c) Viscous - 80/100 bitumen mixed with 5% kerosene by volume. (Suitable for surface dressing work etc.)

Constituents: The 80/100 bitumen used for making cut-back bitumen must conform in all respects to the relevant Specification. The cutting oil shall be normal commercially available kerosene free from any dirt or other impurities.

Mixing:

The bituminous binder shall be penetration grade 80/100 bitumen cut-back with kerosene so that the total diluent content of the binder is in accordance with Table 4.1. Binder which is sprayed while the shade air temperature of the site is rising shall be blended in accordance with the maximum expected temperature on the day. The maximum temperature shall be estimated by the Contractor and approved by the Engineer. Binder sprayed while the shade air temperature is falling shall be blended in accordance with the shade air temperature measured at the time of spraying. Interpolation may be used to obtain intermediate values from Table 4.1. The formulations may be used over a range of $\pm 3^{\circ}\text{C}$ from the specified temperatures except that where no kerosene is required the upper temperature limit shall not apply. Binder not complying with this specification shall not be used without re-blending.

Total diluents (diesel, kerosene) for 80/100 penetration grade bitumen

Shade air Temperature °C	Parts per hundred parts of bitumen binder at 15°C
12.5	16
15.0	14
17.5	12
20.0	10
22.5	8
25.0	6
27.5	4
30.0	2
32.5	
and over	0

Blending:

The total quantity of each component incorporated into the bituminous binder shall be accurately measured by a volume metering or weighing device. The binder shall be thoroughly mixed before use. The minimum acceptable degree of mixing shall be such that the concentration of any component in any part shall not differ by more than 15% from the concentration calculated assuming that the binder is perfectly mixed. All plant and methods used to be blend the binder shall be approved by the Engineer.

The Engineer may by specific direction require that cutback and/or flux oil to be blended either at a central blending plant or on site. When blending is done in a central blending plant, the Contractor shall provide a blending certificate with each load of binder. The certificate shall list the following:

Time and date of blending,

Temperature of bitumen when blended,

Grade of bitumen,

Number of parts of diesel per 100 of bitumen,

Number of parts of kerosene per 100 parts of bitumen,

Type and quantity of other additives (in parts per 100 parts of bitumen) as well as the quantity in either kilograms or litres at 15°C.

If the Contractor fails to provide the specified blend or to provide accurate delivery certificates, the Engineer will require the Contractor to blend only in the presence of and at times and locations previously approved by the Engineer.

Application temperatures of bituminous binder materials

Where the binder, or its bitumen component, is to be stored for a period exceeding one week, it shall be stored at a temperature not exceeding 150°C. The quantity of bituminous binder or bitumen raised above this temperature in any one day should not exceed that which is to be sprayed on that day.

Where binder which has been heated to spraying temperatures must be stored for more than one day, thermostatic heaters shall be used to maintain the binder temperature not higher than 50°C below the appropriate spraying temperature listed in Table below, except with the specific approval of the Engineer.

Any binder which has been heated to a temperature in excess of 30°C above that specified in Table 4.2 for any period, or which has been held in storage at temperatures above those permitted in this specification, shall not be used until it has been re-tested for compliance with these specifications.

a) Penetration Grades

Penetration grade bitumen will be sprayed at the highest temperature possible to gain time for spreading and rolling of chips. However, in no case may the temperature at any time exceed 180°C.

b) Bituminous Emulsions

Emulsified bitumen shall not be reheated above a temperature of 90°C nor stored in such as to allow deterioration of its properties. Emulsified bitumen shall be continuously circulated to ensure a uniform temperature throughout. Any emulsified bitumen showing lack of uniformity will be condemned and shall immediately be removed from the site of the works. The emulsified bitumen may be sprayed at the temperature at which it is received from the manufacturing plant except that no emulsified bitumen shall be sprayed at a temperature in excess of 90°C or below 20°C.

c) Cut-back bitumen

The binder, according to its composition, shall be sprayed at a spraying temperature within the limits defined in Table below.

Precautions: Kerosene is highly inflammable and care must be taken at all times to prevent fire. Kerosene should be stored in sealed metal drums away from naked flames. Mixing shall be carried out away from fires or other naked flames and fire fighting appliances shall be located within 30 metres ready for use.

Spraying temperatures for cut-back bitumen based on 80/100 penetration grade bitumen

Total Diluent	Temperature ° C	Total Diluent	Temperature ° C
0	185	11	157
1	182	12	154
2	180	13	151
3	177	14	148
4	175	15	146
5	172	16	144
6	170	17	141
7	167	18	139
8	164	19	136
9	162	20	133
10	150	--	--

Notes: 1. Total diluent refers to the total quantity of diluents expressed as parts per hundred parts of bitumen (measurement by volume at 15°C).

2. Binder may be sprayed at temperatures varying not more than 10°C from these tabulated values.

3. This table does not apply to binders containing diluents other than those listed in note 1.

Measurement

Bituminous materials shall be measured by volume at 15oC for payment. The following table shall be used for computing volumes of materials stored or used at other temperatures:

Volume Correction Table

(Multipliers for reducing the volume of hot bitumen to the equivalent volume at 15oC)

Observed Temperature					
(°C)	Multiplier	(°C)	Multiplier	(°C)	Multiplier
15	1.000	81	0.959	147	0.920
18	0.998	84	0.957	150	0.918
21	0.996	87	0.956	153	0.916
24	0.994	90	0.954	156	0.914
27	0.993	93	0.952	159	0.913
30	0.991	96	0.950	162	0.911
33	0.989	99	0.948	165	0.909
36	0.987	102	0.946	168	0.907
39	0.985	105	0.945	171	0.905
42	0.983	108	0.943	174	0.904
45	0.981	111	0.941	177	0.902
48	0.979	114	0.939	180	0.900
51	0.978	117	0.937	183	0.899
54	0.976	120	0.936	186	0.897
57	0.974	123	0.934	189	0.895
60	0.972	126	0.932	192	0.893
63	0.970	129	0.930	195	0.892
66	0.968	132	0.928	198	0.890
69	0.967	135	0.927	201	0.888
72	0.965	138	0.925	204	0.886
75	0.963	141	0.923		
78	0.961	144	0.921		

Asphalt Mix Types

The type of hot (or cold for patches) asphalt mixes shall be as indicated on the Drawings or as directed by the Engineer.

Asphalt Concrete Surface Course

Asphalt Concrete Surface Course is intended as the top layer of pavement that is exposed to the traffic. It is placed on a binder or leveling course, or existing asphalt surface, the surface of which has been prepared with a Tack coat.

Asphalt Concrete Binder Course

Asphalt Concrete Binder Course, when required by drawings, is intended as the layer of pavement immediately below the Asphalt Concrete Surface Course. It is placed on a base course, the surface of which has been prepared with a Prime Coat if the base material is unbound crushed stone or Tack Coat if the base material is an asphalt base course.

Asphalt Concrete Base Course

Asphalt Concrete Base Course (Also referred to as asphalt treated base course (ATB)), when required by drawings, is intended as the layer of pavement immediately below the Asphalt Concrete Binder Course. It is intended to be placed directly on a prepared sub-grade or sub-base material in substitution for unbound base and sub-base materials. Asphalt Concrete Binder Course may be substituted for the material specified herein as Asphalt Concrete Base Course, with the Engineer's authorization.

ASPHALT layer Thickness and Surface Tolerances

The thickness of asphalt concrete laid shall be monitored by pavement cores taken by the Contractor under the supervision of the Engineer. 100mm cores shall be taken for both compaction and thickness checked at 100m intervals on alternate sides of each paved area, 0.5 m from the edges. Repeat cores shall be taken 1m on either side of failure cores, until the extent of the affected area is known.

The actual thickness of asphalt concrete placed over any given section of the Works shall be defined per lot in accordance with requirements and procedures noted in this specification.

The pavement must conform to the designed finished grade shown on the Drawings. The finished surface levels of the asphalt surfacing shall conform to the design finish grade at all points.

The variation of the finished surface of asphalt mixes used as binder courses from a 3 m straightedge shall not exceed 7 mm at any point and 13 mm for asphalt base courses.

The variation of the finished surface of asphalt wearing courses from a 3 m-straightedge shall not exceed 5 mm at any point.

The tolerance accepted for the final level on the wearing course from the specified design levels shall be – 0 mm, + 5 mm.

BITUMINOUS MACADAM BASE COURSE (Penetration Method)

Description

This item shall consist of a base course of bituminous macadam composed of crushed stone aggregate and bituminous material applied by penetration methods, and shall be constructed on completed and accepted aggregate base course, sub-base or existing pavement with a tack coat in accordance with these Specifications and in conformity with the lines, grades, and typical cross-sections shown on the Drawings and approved by the Engineer.

Bituminous Material

Bituminous material for the asphalt concrete base course shall be AC-20 grade asphalt cement, conforming to the requirements of AASHTO M 226. Bituminous material conforming to the requirements of 60/70 Penetration Grade will be accepted as equivalent to AC-20 grade asphalt cement.

Bituminous material for the asphalt concrete surface course shall be AC-20 grade asphalt cement, conforming to the requirements of AASHTO M 226.

Bituminous material conforming to the requirements of 60/70 Penetration Grade will be accepted as equivalent to AC-20 grade asphalt cement.

Other grades of Asphalt will be permitted only with the prior approval of the Engineer. Any and all deliveries of bitumen to site shall be sampled and tested with at least 4 samples being taken or as directed by the Engineer.

At least 4 separate sub-samples will be taken for each sample.

Aggregates

a) Coarse Aggregates

The coarse aggregates shall be well graded broken stone and meet the requirements of Section 3302 Aggregate base, for crushed stone except as otherwise specified herein or approved by the Engineer. Coarse aggregate sizes shall have at least 90 percent by weight of pieces with two fractured faces and at least 98 per cent by weight shall have at least one fractured face. Thin flat flaky or over sized aggregate detrimental to compaction and effective choking shall not be used. The flakiness index as determined in accordance with BS812 shall be not greater than 30%.

Permissible variations in the grading of coarse aggregates are shown below.

Aggregates may be mixed or blended to achieve the grading if approved by the Engineer.

Permissible Gradation of Coarse Aggregates

Table

Sieve Size mm	Percentage Passing by mass	
	75 mm layer	63 mm layer

50	100	
37.5	90 - 100	100
19	30 - 65	80 - 100
12.5		30 - 70
9.5	0 - 20	0 - 30
4.75	0 - 5	0 - 5

The abrasion resistance of coarse aggregates shall be measured by the Los Angeles Abrasion Test (AASHTO Test Method T-96). The maximum allowable abrasion loss for bituminous macadam coarse aggregate shall be 35% by weight. When tested in accordance with the Method of Test for Soundness of Aggregates by use of Sodium Sulphate, AASHTO Test Method T-104, the weighted average loss in five cycles shall not exceed 15% by weight.

b) Choke Aggregate

The fine or choke aggregate for bituminous macadam shall comply with one of the following gradings as approved by the Engineer.

Permissible Gradations of Choke Aggregate

Sieve Size mm	Total Percent Passing by Mass		
	Type A	Type B	Type C
19	100	100	
12.5	90 - 100	90 - 100	100
9.5	40 - 70		95 - 100
6.3	0 - 15	10 - 35	60 - 90
4.75 2.36		0 - 5	0 - 10
1.18	0 - 5		0 - 5

The fine aggregate or sand used as choke aggregate shall be either a natural or manufactured product, which must be dust free and meeting above gradation sizes except as otherwise specified herein.

BITUMINOUS PRIME COAT AND TACK COAT

Description

This item shall consist of the careful cleaning of a base, wearing course or an existing road surface and the application of a prime coat or tack coat of bituminous material as described in these Specifications.

Materials

a) Prime Coat

The primer seal or prime coat shall be 80/100 bitumen mixed with 30%-35% kerosene by volume or alternative primer of a grade approved by the Engineer.

The primer application rate shall nominally be 1.0 litres per sq.m (residual bitumen) but shall be within the range 0.80 - 1.40 litres per sq.m as directed by the Engineer.

When specifically approved by the Engineer bitumen without kerosene may be used.

b) Tack Coat

A tack coat shall be applied where directed to bond a new bituminous surface to an older bituminous surface. A tack coat shall comprise a light application of bituminous material

in a similar manner to the prime coat. The tack coat shall be 80/100 bitumen mixed with 0% - 5% kerosene by volume.

Spray rates (for residual bitumen) shall nominally be 0.2 litres per sq. metre but shall be in the range 0.1 to 0.5 litres per sq. metre as required for the existing surface and ordered by the Engineer.

Where a tack coat is required in the Engineers opinion only to overcome a delay or damage to a bitumen surface, which could have been reasonably prevented by the Contractor, then the tack coat shall be applied at the Contractor's expense and shall not be measured for payment.

c) Primer seal Aggregate

Sand for primer seal aggregate shall meet the requirements of chokes aggregate Type C or as approved by the Engineer.

The application rate for the aggregate shall be within the range 0.007 - 0.012 cum per sq. metre to the approval of the Engineer.

BITUMINOUS PREMIX SURFACE COURSE (HOT ROLLED ASPHALT)

Description

This item shall consist of one or more courses of compacted bituminous premix constructed on the prepared base, or existing pavement, in accordance with these Specifications and in conformity with the lines, grades, designed thickness, typical cross sections and other details shown on the Drawings or approved by the Engineer.

The bituminous premix shall be composed of a mixture of coarse and fine aggregate, approved mineral filler and bitumen. The mix shall be nominal 20 mm maximum size unless the Engineer directs that a mix of 10 mm nominal maximum size be used in locations where minor correction layers are required.

Materials

a) Binder Unless otherwise noted on the Drawings or in the Special Provisions the binder used shall have penetration grade bitumen meeting the requirements of Section 4202. It shall not be cut back.

b) Coarse Aggregate Coarse aggregate (material retained on the 2.36 mm Sieve), shall be crushed stone, crushed slag or crushed gravel. The sodium sulphate soundness loss shall not exceed 9 percent and the magnesium sulphate loss shall not exceed 12 percent when tested in accordance with AASHTO T104. All crushed aggregate shall be produced by means of a Cone Crusher unless otherwise directed by the Engineer.

The abrasion resistance of coarse aggregates shall be measured by the Los Angeles Abrasion Test (AASHTO Designation T-96). The maximum allowable abrasion loss for bituminous premix coarse aggregate shall be 30% by weight.

When crushed gravel is used not less than 95 percent by weight of the particles retained on the 4.75 mm sieve shall have less than two fractured faces.

The coarse aggregate shall be of such gradation that when combined with the other aggregate fractions in proper proportion the resultant mixture will meet the gradation required under the composition of the mixture for the specific type under contract.

c) Fine Aggregate

The fine aggregate shall be defined as material passing the 2.36 mm sieve and shall be either a natural or manufactured product, the surface of which shall be clean and free from clay and any deleterious coatings. The Plasticity Index of the material passing the 0.425 mm sieve shall not exceed 4 and shall have a sand equivalent not less than 50 as determined by the Sand Equivalent Test AASHTO T176.

The material shall be graded uniformly from coarse to fine and may be supplied as two or more components capable of being combined with the coarse aggregates to produce a satisfactory overall combined grading.

d) Mineral Filler

Mineral filler shall consist of rock dust, hydrated lime or Portland cement. It shall be dry and free from lumps and shall meet the following grading requirements:

e) Sampling, Testing and Approval of Materials

Prior to the delivery of any mineral aggregate or mineral filler, the Contractor shall furnish and test samples under the supervision of the Engineer. At the completion of the tests the Engineer will inform the Contractor if such materials as represented by the samples conform to the requirements of the Specifications. Permission to use a material shall not be construed as an approval of the source of supply of this material.

Upon the initial delivery or manufacture of the materials and during subsequent deliveries and manufacture, samples will be taken and tested to determine that the materials being furnished conform to the original samples and also to the requirements of these Specifications. For each day of production the Contractor shall test at least two samples of all materials entering into uncompacted pavement. All tests will be performed by the Contractor under the supervision of the Engineer unless the Engineer chooses to separately test the samples.

The test procedures to be used are as listed below although the Engineer may specify other tests should these be required.

Characteristic	Method of Test	
	AASHTO	ASTM
Materials Finer than 0.075 mm sieve	T 11	C 117
Unit Weight of Aggregate	T 19	C 29
Sieve analysis of Fine and Coarse Aggregates	T 27	C 136
Sieve Analysis of Mineral filler	T 37	C 546
Resistance to Abrasion of Coarse Aggregate using Los Angeles Machine	T 96	C 131
Soundness of Aggregates by use of Sodium Sulphate	T 104	C 88
Plastic Fines in Graded Aggregates and Soil by use of the Sand Equivalent Test	T 176	-
Asphalt Content by Quantities Extraction	T164	D2172
Mechanical Analysis of Extracted Aggregate	T30	-

Job Mix Formula

The table following gives the composition limits within which the Job Mix Formula will be set by the Engineer. After examination of the materials that the Contractor proposes to use, and following tests of trial mixes by the Contractor, the Engineer shall establish the Job Mix Formula. Should the Contractor at any time propose to change the source or processing of the materials, sufficient notice shall be given the Engineer before such change is made. Samples shall be provided and tested by the Contractor supervised by the Engineer so that the mix design may be checked and the Job Mix Formula amended as necessary.

The Engineer may vary the Job Mix Formula to suit changing materials or to improve workability but no change shall be made unless authorised by the Engineer.

Aggregate Gradation for Hot Asphalt mixes (Ref.- Asphalt Institute MS-22, 2nd Edition)

Sieve Size mm	% Passing by Weight of Total Aggregate in mix	
	Asphalt concrete Binder course (19 mm)	Asphalt Surface Course (12.5 mm)
25	100	
19	90 - 100	
12.5	-	90-100
9.5	56 - 80	-
6.7	-	-
4.75	35- 65	44-74
2.36	23 - 49	28-58
1.18	-	-
0.300	05 - 19	5-21
0.075	3 – 8	3-8
Asphaltic Cement by weight of total mix %	4.0-5.0	4.5-6.0

Construction Methods

a) Cleaning of Base of Old Pavement

Immediately prior to the arrival of the mix at the paving site, the base, levelling course or old pavement to be surfaced shall have been thoroughly cleaned of all soil or foreign materials. Unstable or fatty patches of surplus bituminous material shall be removed from the old pavement and be replaced where necessary with suitable material, before spreading of any of the bituminous mixtures.

b) Transportation and Placing of Mixtures

Mixtures shall be transported to the work in trucks having tight, clean and smooth metal beds that have been sprayed or painted with a minimum amount of soapy water to prevent mixture from adhering to the beds. No load shall leave the plant that is not thoroughly protected by a waterproof canvas cover. Any truck causing excessive segregation of materials by its spring suspension or other contributing factors, or that shows oil leaks of any magnitude, or that causes undue delays, shall upon the direction of the Engineer be discharged from the work until such conditions are corrected.

Recording of Truck Weights - A digital recorder shall be installed as part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process. In addition, the system shall be so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately weigh the heaviest loaded trucks or tractor trailers that are used for the delivery of the bituminous concrete from that plant. When any mixtures are being transported at shade air temperatures below 10°C or when the length of haul exceeds 10 kilometres, all truck beds shall be insulated to maintain workable temperature of the mixture. The maximum distance mixtures may be transported from mixing plant to paving site shall not exceed 30 kilometres except by specific permission of the Engineer.

Mix shall be dumped into the hoppers of the spreading and finishing machines

Alternative labour - intensive spreading and finishing methods will require the prior approval of the Engineer, and will only be permitted for small irregular areas of work. Except as specified below, no loads of mix shall be despatched from the plant so late in the day that they cannot be spread, compacted and completed in daylight. The Engineer may permit the surface course to be constructed after daylight hours, provided sufficient artificial illumination is available and that the work performed complies in every respect to this Specification.

No mix shall be spread when the base or supporting course is wet or when other conditions prevent proper spreading, finishing or compacting.

c) Spreading and Finishing

Bituminous premix shall be spread by self-powered pavers, which shall be capable of spreading and finishing the mixtures true to the line, grade and crown shown on the Drawings or set by the Engineer, without the use of forms or side supports.

No mix shall be placed when weather conditions are such that proper spreading, finishing, compaction and bonding may not be obtained.

A longitudinal joint when adjoining lane is not placed the same day or has become distorted by traffic or other means, shall be carefully trimmed to line and shall have a near vertical face. The face shall be coated with a thin layer of seal coat before placing the abutting material.

Transverse joint shall be constructed and compacted to provide a smooth riding surface. The joints should be straight and be trimmed to a near vertical face and coated with a thin layer of seal coat prior to the placing of fresh material adjacent to the joint.

Faces of castings, kerbs, gutters, concrete pavement etc. against which the mix is to be placed shall be painted or sealed with bituminous material. The cost of the painting or

sealing shall be included in the price bid for bituminous premix and no separate payment shall be made therefore.

Immediately after any course is screeded and before compaction has commenced, the surface shall be checked, any irregularities adjusted, all foreign material removed by a rake or hoe and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the rolling of the edge is performed.

The Contractor shall provide competent workmen who are capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given to the straight edging of each course immediately following the initial rolling.

Any areas such as intersections, turnouts or driveways that are impracticable to be constructed by machine intensive methods shall be spread and finished by acceptable hand methods.

d) Compaction

After spreading, the mixture shall be thoroughly and uniformly compacted. The density of the completed pavement shall be in accordance with the requirements specified below.

Steel wheel rollers shall be tandem static/vibratory rollers unless otherwise approved by the Engineer. Pneumatic tyred rollers shall have a minimum of 7 wheels and be capable of adjusting tyre pressure while moving. Rolling shall be carried out in three sequences:

- * Breakdown rolling by steel wheel roller at a temperature not less than 110oC
- * Secondary rolling by pneumatic tyred roller
- * Finish rolling, by smooth wheel vibrating or static rollers at a temperature not less than 70oC.

The number of rollers used shall be sufficient to compact at a rate not less than the rate of paving, making due allowance for rapid cooling at low temperature. At all times, the motion of the rollers shall be slow enough to avoid displacement of the mix. Rolling shall commence as close behind the paver as is practicable and shall be continued until all roller marks are eliminated and no further compaction is possible. The initial pass of the roller over the uncompacted surface shall be with the powered drive wheel towards the paver.

To prevent the adhesion of mix the roller drums and tyres shall be kept moist for their full width, but an excess of water will not be permitted.

In general, rolling shall begin at the sides and shall progress toward the centre, parallel to the centreline of the roadway. Successive passes of the roller shall uniformly lap the previous passes. On superelevated curves, rolling shall start at the low side and progress to the high side as above described. Where a longitudinal joint is being made, the joint shall be thoroughly rolled before starting at the edge to roll inward. Alternate passes of the roller shall be terminated in steps at least 1 metre distant from any preceding stop, and such stops shall be so regulated as to preclude the trapping of any water on the rolled surface. Other rolling procedures may be approved or directed by the Engineer as conditions require.

In areas adjacent to kerbs, compaction shall be performed with a reciprocating tamper or trench roller, or other method, to the approval of the Engineer. In other areas inaccessible to any roller the required density shall be secured by the use of tampers or other compaction equipment meeting the approval of the Engineer.

The Contractor shall employ only bituminous surfacing skilled operators, supervisors and drivers who are capable of adjusting their operations to the observed conditions.

Where the paving and rolling of the surfacing is not carried out in a workmanlike manner the Engineer may suspend surfacing operations until suitably skilled workmen and operators are provided by the Contractor.

e) Small Tools and Portable Equipment

The Contractor shall provide all necessary tools and keep them in first-class condition. Sufficient number of standard 3000 mm straight edges or surface testers for bituminous pavements and standard templates constructed to the true cross section of the road shall be provided by the Contractor and shall be available at all times at all individual work sites where they may be required to be used. This provision shall be complied with before work is started.

f) Surface Tolerances The finished surface shall not vary more than 3 mm from a template cut to the cross section of the course, nor more than 3 mm from a 3000 mm edge applied parallel to the centreline of the pavement nor shall any portion be more than 3 mm below or above the finished level shown on the Drawings or instructed by the Engineer. Portions of the completed pavement that do not comply with the requirements of the Specifications shall be taken up, removed and replaced or otherwise corrected in a manner satisfactory to the Engineer. These corrections shall be made at the Contractor's cost.

g) Protection of Wearing Course

After the completion of the wearing course, no vehicular traffic shall be allowed on the pavement until it has so cooled that its surface will not glaze or flush. Upon completion of the final rolling, suitable barricades shall be placed on the surface of the course at such intervals as will keep vehicular traffic off the course. The minimum period of protection shall be 6 hours after placing and when the shade air temperature is above 30°C the protection shall be lengthened by the Engineer as required but in no case shall this exceed 10 hours.

h) Plant Tickets

When batch mixers are used, the number of batches and total net weight of all loads of mix shall be recorded in triplicate upon Engineer's Plant Ticket forms by an authorised representative of the Engineer. The Contractor shall install and regularly calibrate an acceptable weigh bridge to weigh the mix transporting vehicles and shall provide suitable plant tickets to the Engineer's requirements. Installation of a weigh bridge is a mandatory requirement for this contract.

With each load delivered to the Work, the driver shall present one copy of the plant ticket to the Engineer's representative and another to the authorised representative of the Contractor. The plant inspector shall keep the third copy until the completion of the Work and then forward it to the Engineer. Any changes in the amounts set forth on the tickets, necessitated by the rejection of any material or in the designation as to where material is

used, shall be noted by the Engineer's representative upon all copies, and a reason stated for such rejection. At any time during the delivery of material for the purpose of checking the operation and weighing equipment of the plant, the Engineer may direct the Contractor to weigh or cause to be weighed, on tested and approved scales at the Contractor's expense, any truck either full or empty engaged in delivery of mix to the Works.

i) Sampling Pavement

For the determination of thickness and density of the compacted mix, the Contractor under the supervision of the Engineer will take core samples of the pavement. These cores shall be a minimum 75 mm diameter and taken at intervals of not more than 200 lane metres or 2 per day whichever gives the greater number of samples.

If the bulk density of the compacted mix determined from these cores is less than 95 percent of the design density of the mix, such additional rolling or modification of rolling shall be initiated at once as will secure this result. This rolling shall be carried out when the ambient temperature is high and shall employ pneumatic tyred rollers at maximum tyre pressure. Steel wheeled rollers shall not be used. Upon completion of rolling, further cores will be taken and tested as above. If the results remain less than the required value, the Engineer may direct that the mix represented by this core be removed from the works and replaced at the Contractor's expense.

j) Thickness

The total thickness of bituminous premix courses determined as herein specified, shall be not less than the design thickness, and shall not be more than 6 mm greater. When the total thickness is less than the minimum specified, the deficient area shall be corrected at the Contractor's expense either by an overlay course, or by removal and replacement of the unsatisfactory thickness. The corrective measures will be subject to the approval of the Engineer.

k) Acceptance Sampling and Testing of Bituminous Mixture

The mean and range of the density of the pavement will be calculated from the results of all tests run on randomly selected sites each two production days. Regardless of the quantity of pavement placed, no less than ten tests will be run. The compaction of the lot will be considered acceptable when the average of all test results for two production days is equal to or greater than 95% of the target density plus 0.35 times the range (the difference between the largest and smallest test result).

In addition to the tests which are run on randomly selected sites, the Engineer reserves the right to test any area which appears defective and to require further compaction of areas that do not have at least 95 percent of target density.

The in-situ and target densities shall be measured in terms of "Bulk Specific Gravity" as determined by AASHTO T166. The target density test specimen shall be determined using the procedure for test specimen preparation including mixing, moulding and curing described in AASHTO T167. (Compressive Strength of Bituminous Mixtures').

When the thickness of a sample is found to be less than the minimum permissible pavement thickness, two additional samples shall be cut at locations 2 m longitudinally in both directions from the location of the deficient sample. If both of these samples give thicknesses more than the design thickness, the represented shall be considered

satisfactory and no correction shall be required. If either or both of these samples are deficient in thickness, additional samples shall be taken in the direction or directions of deficiency indicated, at intervals of 30 metres measured longitudinally from the location of the first deficient sample, until a pavement thickness within the specified tolerance limits is found.

If an overlay is used for correction it shall be placed for the full width of the pavement over the entire area of deficiency and shall have butt joints at the ends. A tack coat meeting the requirements of the Contract Specification shall be applied at the expense of the Contractor.

The overlay course shall be not less than a 20 mm thickness of 10 mm mix or 40 mm of 20 mm mix and it shall not be measured for payment.

If the deficient area in a lane is removed and replaced, the courses shall be stepped into adjoining pavement for a distance of 500 mm at the ends and 300 mm at the edges. The area of deficiency in this case need not extend to the limiting sample locations described above, but shall extend to the point where the thickness of the exposed edge of bituminous premix remaining is found to be of satisfactory thickness. The supporting base course shall be regarded and re-compacted if necessary, and the various courses replaced. The overall thickness of the replaced courses shall be within the tolerances specified.

Method of measurement

Measurement for bituminous premix surface course of the various thicknesses specified shall be made in Sqm or ton accepted with no deduction made for the mass of bitumen in the mixture. The material shall be weighed after mixing when placed in the delivery trucks, each of which shall have a tare mass certified to the satisfaction of the Engineer. Loaded trucks shall be weighed as herein before specified.

The summation of certified delivered masses shall be the basis for payment of this item after due allowance has been made for any wasted material and any material rejected by the Engineer for non compliance with any of the specified requirements and subject to the limitation set out in the next paragraph.

The Contractor shall cooperate with the Engineer in establishing, by field trial on the Works, the rate of spread (tonnes per square metre) for the bituminous premix surface course.

Thereafter, the payment mass for surface course, as determined by weighbridge docket, after adjustment as provided for herein above, must be within 7 percent of the rate computed using the rate of spread determined by field trial, the comparison being on a daily basis. Payment will not be made for any mass determined by weighbridge docket which is more than 7 percent below the mass computed by rate of spread, pending investigation by the Engineer and the carrying out, at the Contractor's expense, of any repairs to the affected area deemed necessary by the Engineer. Bitumen used in the mix shall be deemed to be included and shall not be measured separately irrespective of its quantity. No price adjustment shall be made in case the quantity of bitumen used becomes more or less because of change in job mix formula during the process of the works.