PART 5 PAVEMENTS AND ROAD ANCILLARIES WORKS

501 SCOPE

The work covered by this Clause of these technical Specifications shall consist of furnishing all plants, equipment, material and labour and in performing all operations in connection with the construction of the graded stone subbase course, bituminous base course, bituminous concrete wearing course, verges and slopes of embankment, kerbs, guardrails, traffic signs, and road markings on a prepared surface, complete, subject to the Contract, and in strict accordance with this Clause of these Technical Specifications and the applicable Drawings.

502 PREPARATION OF SUBGRADE SURFACE

Prior to construction of the subbase, the previously prepared subgrade shall be cleaned of all foreign substances. Any ruts, or soft yielding spots which occur in the subgrade, any area having inadequate compaction, or any deviations of surface from the requirements specified, shall be corrected by scarifying, removing and/or adding approved material, reshaping and recompacting the unsatisfactory areas to the required density and to the established line and grade. Appreciable irregularities in the surface of the subgrade shall be corrected by blading and rolling, adding water where necessary at the Contractor's expense. In the preparation of subgrade surface, the additional proof-rolling may be required by the Engineer.

503 GRADED STONE SUBBASE

503.01 Materials

The graded stone subbase materials shall conform to the requirements of sub-clause 906.04 of these Specifications.

The material shall conform to the following gradation limits:

Sieve (mm)	Passing per cent by weight
50	100
40	80 - 100
20	55 - 100
5	30 - 70
2.5	20 - 55
0.4	5 - 30
0.074	2 - 10

The gradation as used in the work shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, but shall be uniformly graded.

503.02 Construction Requirements and Construction Methods

(1) Weather Limitations

Subbase shall be constructed only when weather conditions do not detrimentally affect the quality of the finished course.

(2) Placing and Spreading

Placing and spreading shall be provided and laid to the lines, levels and

cross-section shown on the Drawings or as directed by the Engineer. The graded stone subbase shall be placed in two layers of equal thickness when the required thickness is more than 15 cm.

Spreading of the approved material shall be carried out by plant or vehicles designed or equipped with suitable devices capable of depositing the material in a continuous uniform layer of the correct thickness, width, shaping, and surface tolerances.

During spreading of material, precautions shall be taken to avoid segregation. If segregation occurs, the Contractor shall remix the material by a method to be approved by the Engineer.

Where it is necessary to add water to adjust the moisture content, the water shall be added by an approved mechanical sprinkler and mixed into the full depth of the loose material by means of a harrow or other mixing equipment approved by the Engineer.

(3) Compaction

Each layer shall be compacted until the entire depth of the course is at least 95 percent of the density at optimum moisture as specified in sub-clause 302.04.

Additional water shall be applied to the material during the rolling operations in amounts as required to obtain the specified density and the optimum moisture content. In all places not accessible to the rolling equipment the material shall be compacted thoroughly with approved mechanical tampers. The surface of the subbase course shall be finished by blading and by rolling with pneumatic tire rollers, until the surface is tight and free from irregularities, and is true to grade and cross-section. If at any time during or after compaction the sub-base is excessively moistened by rain it shall be scarified, aerated, compacted, and finished as specified above at the Contractor's expense.

No superimposing layer should be placed before the previous layer has been approved by the Engineer.

(4) Thickness and Finish

The completed subbase courses will be tested for the required thickness and surface before acceptance. Any areas of the completed subbase having a compacted thickness less than the thickness shown in the respective items of the Bill of Quantities and/or on the Drawings shall be corrected by scarifying the surface, adding approved material, reshaping, recompacting and finishing as specified and as approved by the Engineer. Skin patching of an area without scarifying the surface to permit proper bonding of the added material will not be permitted.

The surface of each subbase course shall be properly shaped to a smooth uniform surface parallel to the finished surface of the carriageway by means of a templet cut to the camber of the finished surface.

(5) Maintenance of Subbase

The completed subbase shall be maintained in an acceptable condition at all times, as directed by the Engineer, prior to the construction of the base course.

(6) Tolerances

The finished surface shall not show any departure from the required formation height greater than within the range -1 cm to +2 cm.

The deflections of the surface of each subbase course shall not be greater than 1 cm, when tested with a 3 m straight edge.

If for two consecutive working days more than 10 per cent of the measurements do not comply with these requirements, the work shall be stopped in order to examine and improve the methods and equipments and if necessary substitute any defective equipment.

503.03 Sampling and Testing

The following tests may be required for each subbase layer as often as deemed necessary to insure compliance with the requirements of these Specifications: Gradation, Compaction, In-situ-density and Plate bearing test.

Any material found to be in nonconformance with the requirements will be caused for rejection. All rejected material shall be removed and replaced by the Contractor with material meeting the requirements at the Contractor's expense.

The Contractor shall take samples as and where required by the Engineer, to provide all necessary containers and wrappings and to dispatch to the Site Testing Laboratory.

503.04 Measurement

The Graded stone subbase of different thickness will be measured by the square meters of completed and accepted subbase in place. The number of square meters of the completed subbase shall be determined by the length measured along the center line and upon the surface of the subbase, times the width as shown on the drawings plus the areas of any widening on curves, turnouts and intersections, authorized by the Engineer and measured separately.

503.05 Payment

The accepted quantities of the graded stone subbase, will be paid for at the contract unit price per square meter, which payment shall constitute full compensation for the construction and completion of the subbase, including preparation of subgrade, the furnishing of materials, supplies, plants, equipment, tools and labour; the handling, manipulating, placing, shaping, compacting, including the necessary water for compaction, rolling and finishing; correcting unsatisfactory areas, testing of materials and density; maintenance; and for furnishing of all other labour, and incidentals necessary to complete the work required by this Clause of these Specifications.

Payment will be made under:

	Pay Item	Pay Unit
E01.	Supply, laying and compaction of Graded Stone Subbase Course or Base Course after compaction on prepared subgrade of road	
01	Graded stone subbase course, 30 cm thick for main road carriageway	m2
02	Graded stone subbase course, 20 cm thick for access road carriageway	m2
03	Graded stone base course, 15 cm thick for shoulder of main road, footway of access road, carriageway of approach road and frontage road	m2
04	Graded stone base course, 10 cm thick for footway of access road	m2

504 BITUMINOUS PRIME AND TACK COAT

504.01 Scope

The work covered by this Clause of these Specifications shall consist in furnishing all plant, labour, equipment, and materials, and in performing all operations in connection with the application of a bituminous prime or tack coat on a previously prepared surface in strict accordance with this Clause of these Specifications and the applicable Drawings.

504.02 Materials

The bituminous prime and tack coat materials shall conform to the requirements of Part 9 of these Specifications.

504.03 Construction Requirements and Construction Methods

(1) Preparation of Graded Stone Subbase for Prime Coat

The finished subbase surface shall be true to line, grade and cross section as specified in sub-clause 505. The subbase shall be in the condition of compaction and finishing specified.

The surface shall be thoroughly brushed and all loose sand, dust, dirt and other detrimental material shall be removed.

(2) Weather Limitations

The coat shall be applied only when the surface to be treated is dry, or contains moisture not in excess of that which will permit uniform distribution and the desired penetrations.

(3) Quantities to be Applied

(a) Prime Coat

Bituminous material shall be applied in quantities to 1.0 kg/m2.

(b) Tack Coat

Bituminous material shall be applied in quantities of 0.6 kg/m2.

(4) Application of Bituminous Material

(a) General

Immediately following the preparation of the surface, the bituminous material shall be applied by means of the pressure distributor at a temperature of 65°C to 85°C, and at the pressure and in the amounts as directed by the Engineer. The material shall be applied so that uniform distribution is obtained at all points of the surface to be applied. All spots unavoidably missed by the distributor shall be properly treated with bituminous material.

(b) Prime Coat

Following the application of prime material, the surface shall be allowed to cure for a period of approx. 48 hours without being disturbed, or for such additional period of time as may be necessary to attain penetration into the subbase course and aeration of the volatiles from the prime material. The Contractor shall furnish and spread sufficient approved sand on all areas which show an excess of bituminous material to effectively blot up the excess, as directed by the Engineer.

(c) Tack Coat

The tack coat shall be applied only a short distance and not more than

two hours in advance of the placement of the bituminous mixture so as to provide a thin adhesive film of bitumen to insure a good bond.

(5) Maintenance

The treated surface shall be maintained in satisfactory condition until the succeeding layer of pavement has been placed. During this interval the Contractor shall protect the treated surface against damage and shall repair all broken spots.

504.04 Measurement

The prime or tack coat shall be measured by the tonnage of applied prime or tack coat in accordance with these Specifications. Measurement for payment will not consider any bituminous material placed in excess of the specified rate of application.

504.05 Payment

The accepted quantities of the prime or tack coat will be paid for at the contract unit price per square meter, which payment shall constitute full compensation for furnishing, delivering and applying the materials, for maintenance, and for all labour and incidentals necessary to complete the work required by this clause of these Specifications.

Payment will be made under:

Pay Item		Pay Unit
E02.	Supply and spray of Bituminous Prime and Tack Coat	
01	Bituminous Prime Coat at the rate of 1.0 kg to the square meter of prepared subbase course of roads	t

02	Bituminous Tack Coat at the rate of 0.6 kg to the square meter of prepared base course of roads	t

505 BITUMINOUS TREATED BASE COURSE

505.01 Scope

The work covered by this Clause of these Specifications shall consist in furnishing all plant, labour, equipment and materials and in performing all operations in connection with the construction of bituminous treated base course on a previously prepared subbase, complete, subject to the Contract, and in strict accordance with this Clause of these Specifications and applicable Drawings.

505.02 Materials

The bituminous treated base course materials shall conform to the relevant sub-clause of these Specifications.

505.03 Composition of Mixture

The aggregate as used in the work shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, but shall be uniformly graded. Adjustment of the aggregate gradation and/or bitumen content within the foregoing limit may be made as directed by the Engineer.

Sieve (mm)	Passing per cent by weight
50	100
40	95 - 100
20	50 - 100
2.5	20 - 60
0.074	0 - 10
Bitumen percentage by weight of total aggregate	3.5 - 4.5%

505.04 Appliance of Clause 506

For mixing plant, equipment, weather limitation, alignment control, mixing, transportation of bituminous mixtures, placing, compaction, joints, the respective sub-clauses of Clause 506 of these Specifications "Bituminous Concrete Pavement" shall govern as far as applicable.

505.05 Construction Requirements and Construction Methods

(1) Preparation of Surface

The surface of subbase shall be within the tolerances specified in sub-clause 503.02 of these Specifications before applying the bituminous treated base course material.

Immediately before applying the bituminous treated base course, the surface of the underlying subbase course shall be thoroughly cleaned of all loose or foreign material as directed. The surface shall be primed in accordance with Clause 504 of these Specifications.

(2) Smoothness

After the completion of the final rolling, the smoothness of course will be checked and any irregularities that exceed the specified tolerances, or that retain water on the surface shall be corrected by removing the defective area and replacing it with a new base course at the Contractor's expense.

(3) Tolerances

The thickness of the completed course will be tested at such intervals as directed by the Engineer.

Where more than 5 mm of the thickness specified in the Bill of Quantities, is missing, the deficient course shall be removed and replaced with a satisfactory base at the Contractor's expense.

The finished surface shall not vary more than 1 cm, when tested with a 3 m straight edge.

505.06 Sampling and Testing

For sampling and testing relevant the relevant sub-clause shall govern with the following modifications:

Stability (Marshall) at 60°C	300 kg
Flow (Marshall)	1 mm to 4 mm
Percent voids in mix	3 - 12

The density shall be more than 97% of the density determined by the Marshall test.

505.07 Measurement

The bituminous treated base will be measured by the square meters of completed bituminous treated base in place. The number of square meters of the completed bituminous treated base shall be determined by the length measured along the center line and upon the surface of the course, times the width as shown on the Drawings, plus the areas of any widening on curves, turnouts, and intersections, authorized and measured separately.

505.08 Payment

The accepted quantities of the completed bituminous treated base will be paid for at the contract unit price per square meter.

No additional payment will be made for any thickness of bituminous treated base in excess of the thickness specified in the Bill of Quantities or shown on the Drawings.

Such payment shall constitute full compensation for preparing the surface of the subbase, furnishing all materials, equipment, plant and tools, handling, mixing, manipulating, placing, shaping, compacting, rolling, and finishing, correcting unsatisfactory areas; and all labour and incidentals necessary to complete the work required by this Clause of these Specifications.

Payment will be made under:

	Pay Item	Pay Unit
E03.	Supply, laying and compaction of Bituminous Treated Base Course, 10 cm thick after compaction on prepared subbase course of roads for the carriageway of main road and access road	m2

506 HOT-MIX BITUMINOUS CONCRETE PAVEMENT

506.01 Scope

The work covered by this Clause of these Specifications consists of furnishing all plant, labour, equipment and materials, and in performing all operations in connection with the construction of hot-mix bituminous concrete pavement for binder and wearing course on a previously prepared base course, complete, subject to the conditions of the Contract, and in accordance with this Clause of these Specifications and applicable Drawings.

506.02 Materials

(a) Aggregates

Aggregates shall meet the applicable requirements of sub-clause 906.04.

(b) Filler

Filler shall meet the applicable requirements of sub-clause 906.04.

(c) Bituminous Materials

The type and grade of bituminous material will be specified in the contract. The grade may be changed on step by the Engineer at no change in unit price.

The bituminous material shall meet the applicable requirements of sub-clause 912. Bituminous material may be conditionally accepted at the source.

506.03 Composition of Mixtures

The composition of mixtures required for determining the job mix formulas shall be in conformity with the following requirements. The gradation shall conform to the following gradation limits.

Sieve (mm)	Passing percent by weight	
	Binder course	Surface course
25	100	-
20	95 - 100	100
13	70 - 90	95 - 100
5	35 - 55	55 - 75
2.5	20 - 35	35 - 50
0.6	11 - 23	18 - 29
0.3	5 - 16	10 - 21
0.15	4 - 12	6 - 16
0.074	2 - 7	4 - 8

The bitumen content as percentage by weight of total aggregate shall be within the following limits:

Binder course	4.5 to 5.5
Wearing course	5.5 to 6.5

The results of the Marshall test shall be as follows:

Percent air voids:	binder course :	5 to 8%
	wearing course:	4 to 6%
Stability value:	binder course :	more than 700 kg
	wearing course:	more than 900 kg
Flow value:	2 mm to 4 mm	

During production of asphalt plant mixes, the proportions of filler and bitumen shall be in conformity with the following requirements:

Range for proportion of filler around the specified filler content: ± (plus or minus) 1 (one) percent of the specified weight of mix.

Range for proportion of bitumen around the specified bitumen content: ± (plus or minus) 5 (five) percent of the specified weight of bitumen.

506.04 Job Mix Formulas

The Contractor shall carry out trial mixes to determine the job mix formulas (gradation of aggregates, precise proportions of bitumen and aggregates) at least 60 days before production of bituminous mixes are started and as soon as possible after commencement of aggregate production.

The study shall permit to check that, in spite of the normal fluctuations of a well adjusted plant, the performances of the materials satisfy the requirements of these Specifications.

The Contractor shall submit for approval of the Engineer the job mix formulas and results of the tests carried out on the trial mixes including the results of tests carried out at ranges of bitumen content from below the proposed bitumen contents to above. Specimen tests at each asphalt content shall be made in quadruplicate.

506.05 Mixing Plant

The mixing plant shall be designed, coordinated, and operated so as to produce mixture within the job-mix formula, and shall have a minimum capacity of 50 tons per hour. The plant shall be a weight-batch type. A volumetric-proportioning, continuous mixing type may be substituted for the above type, provided the equipment has demonstrated that it is

suitable for producing finished mixtures complying with the job-mix formula specified herein. Any plant used shall conform to all the requirements of ASTM standard specification D 995-55 and shall be approved by the Engineer.

506.06 Equipment

All equipment, tools, and machines used in the performance of the work covered by this Clause of these Specifications shall be subject to the approval of the Engineer, and shall be maintained in satisfactory working condition at all times.

(a) Mechanical Spreaders

The spreaders shall be the self-propelled type, equipped with hoppers, distributing screws, adjustable screeds, and equalizing devices, capable of spreading hot bituminous mixtures without tearing, shaving or gouging, and producing a fine surface of specified smoothness. Spreaders shall be designed to operate forward at variable speeds and in reverse travelling speed of not less than 30 meters per minute. Width of lane to be able to constructed by the spreader is not less than 4 meters.

(b) Rollers

Rollers shall be of the steel wheel and pneumatic tire type and shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

(c) Hauling Equipment

Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent the mixture from adhering to the beds. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

506.07 Construction Requirements and Construction Methods

(1) Preparation of Surface

Immediately before applying the bituminous pavement, the surface of the underlying course shall be thoroughly cleaned of all loose or foreign material. The surface of the underlying course shall be primed or tack-coated as directed by the Engineer in accordance with Clause 504.

(2) Weather Limitation

Bituminous course shall be constructed only when the base course or binder course is dry, and when the weather is not rainy.

(3) Mixing

The bituminous mixture shall be produced in an approved plant as specified in sub-clause 506.05.

(a) Preparation of Aggregates

Aggregates shall be furnished in at least three sizes. Each size and/or type of aggregate as delivered shall be stockpiled separately. Where cold feeder bins are used, each fine aggregate shall be placed in a separate bin, or should the number of aggregate sizes or types being

used make this impossible, the fine aggregate shall be thoroughly blended in such manner and in such proportions as directed by the Engineer prior to being placed in the feeder bin. The mechanical feeders shall be adjusted to provide delivery of the desired proportions to the dryer. The aggregate shall be heated and thoroughly dried before entering the hot bins. The temperature of the aggregate, determined as it enters the mixer, shall be such that the temperature of the finished mixture will be within the tolerance specified by the job-mix formula. The heated and dried aggregates shall be screened and conveyed to separate bins ready for mixing with the bituminous material. The heated aggregate shall be separated into at least three sizes as designated or approved by the Engineer. Where mineral filler is required, it may be batched without heating.

(b) Preparation of Bituminous Mixture

The aggregates, prepared as specified hereabove shall be accurately weighed or measured, and conveyed into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. The required amount of bitumen for each batch, or calibrated amount for continuous mixing, shall be introduced into the mixer. In batch mixing, after the aggregates have been introduced into the mixer and mixed for 5 to 10 seconds, the bituminous material shall be added and mixing continued for a period of not less than 30 seconds, and as much longer as may be required to obtain a homogeneous mixture. When a continuous mixer is employed, the mixing time shall be not less than 35 seconds, and as much longer as may be required to obtain a homogeneous mixture. The additional mixing time, when required, shall be determined by the Engineer. The temperature of both the aggregates and bitumen at the time of mixing shall be as determined by the Engineer, but the temperature of the heated bitumen shall never exceed 185°C. The volume of the aggregates and bituminous material shall not be so great as to extend above the tips of the mixer blades when the blades are in the vertical position. All overheated and carbonized mixtures or mixtures which foam or show indication of moisture, will be rejected. When

moisture is detected in the finished mixture, all aggregates in the bins shall be removed and returned to the stockpiles.

(4) Placing

The bituminous pavement shall be constructed in accordance with the required thickness as specified or shown on the Drawings.

The temperature of the mixture when delivered on site shall be as directed by the Engineer, but shall never be less than 120°C.

The spreader shall be adjusted and the speed regulated so that the surface of the course will be smooth and the course of such depth that, when compacted, it will conform to the cross section shown on the Drawings. The length of any lane laid before placing the adjacent lane shall be as directed by the Engineer. Where two spreading machines are operating in staggered echelon, no single lane shall be laid in advance of the adjoining lane further than will permit a satisfactory hot longitudinal joint between lanes. Where forming a hot longitudinal joint the 15 cm strip along the edge against which additional material is to be laid shall not be rolled until such additional material is placed, except when the work is to be discontinued. After the first lane has been placed and rolled, the adjacent lane shall be placed while the unrolled 15 cm strip is hot and in a readily compactible condition. Rolling of the adjacent lane shall begin along the joint. Placing of the mixture shall be as continuous as possible. A sufficient number of experienced shovelers and rakers shall follow the spreading machine, dressing the surface as required to produce a course of uniform surface texture and the required smoothness. In areas where the use of machine spreading is impractical, the mixture may be spread by hand, and dressed with rakes. The loads shall not be dumped any faster than can be properly handled by the shovelers and rakers. Rakers not equipped with stilt sandals shall not be permitted to stand in the hot mixture. Contact surfaces of previously constructed pavement kerbs, manholes, and similar structures shall be painted with a thin coat of cutback

bitumen prior to placing the bituminous mixture.

A templet cut to the camber of the finished course is required. The next layer is not to be superimposed without the approval of the Engineer.

(5) Compaction

Compaction shall be effected by three-wheel roller, tandem rollers and tyrerollers. Rolling of the mixture shall begin as soon after placing at the directed temperature by the Engineer as the mixture will bear the roller without undue displacement. Delays in rolling the freshly spread mixture will not be permitted. Initial rolling shall be effected by tandem rollers, followed immediately by the three-wheel rollers and final rolling shall be carried out by the tyrerollers. Rolling shall start at the extreme sides of the lanes and proceed toward the center of the pavement, over-lapping on successive trips by at least one-half the width of the rear wheel of the three-wheel roller. On superelevated curves, rolling shall begin at the low side and progress toward the high side. Alternate trips of the roller shall be of slightly different lengths. Tests for conformity with the smoothness specified in the following clause will be made immediately after initial compaction, and any deviations in excess of the specified tolerances shall be corrected by loosening the hot surface with rakes and removing or adding material as directed before continuing the rolling. The speed of the rollers shall at all times be slow enough to avoid displacement of the hot mixture. Any displacement of the mixture occurring as the result of reversing the direction of the roller, or from any other cause, shall be corrected at once by loosening the surface with rakes and rerolling. Rolling of the binder and wearing courses shall be continued until all roller marks are eliminated and a density of at least 97 per cent of the laboratory density has been obtained. The laboratory density shall be determined by the Standard Marshall Test Method in accordance with sub-clause 1012.04.

During rolling, the wheels of the rollers shall be moistened to prevent

adhesion of the mixture to the wheels, but an excess of water will not be permitted. The rollers shall be operated by competent and experienced roller men. The minimum number of rollers to be furnished by the Contractor shall consist of one three-wheel roller, one tandem roller and one tyreroller for each spreading machine in operation on the job. In all places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers weighing not less than 15 kg with a tamping face of not more than 300 square centimeters. Skin patching of an area that has been rolled will not be permitted. Any mixture that becomes mixed with foreign material, or is in any way defective, shall be removed, replaced with fresh mixture and recompacted. The rollers shall not be permitted to stand on pavement which has not been fully compacted. Necessary precautions shall be taken to prevent the dropping of oil, grease, gasoline, or other foreign matter on the pavement, either when the rollers are in operation or standing. The Contractor shall provide competent workmen who are capable of performing all work incidental to the correction of all pavement irregularities.

(6) Smoothness

After the completion of the final rolling, the smoothness of the course will be checked, and any irregularities that exceed the specified tolerances, or that retain water on the surface shall be corrected by removing the defective area and replacing it with new pavement at the Contractor's expense.

(7) Joints

All joints shall present the same texture, density and smoothness as other areas of the course. The joints between old and any new lanes, or sections, shall be carefully made in such manner as to insure a continuous bond between the old and new pavement. All trimmed contact surface of previously constructed pavement shall be painted with a thin, uniform coat of cut-back bitumen before the fresh mixture is placed.

(a) Transverse

The roller shall pass over the unprotected end of the freshly laid mixture only when laying of the course is to discontinued for such length of time as to permit the mixture to become cold. The end of the previously laid section shall be trimmed to expose an even, vertical surface for the full thickness of the course. The fresh mixture shall be raked uniformly against the joint and initial compaction secured with the tandem roller, followed by regular rolling.

(b) Longitudinal

The joint of the wearing course shall be near the carriageway's center-line.

The joint of the binder course shall be apart more than 15 cm from the joint of wearing course, and the joint of the bituminous treated base course shall be apart more than 15 cm from the joint of wearing course in the opposite side of that of the wearing course.

When the edges of the longitudinal joints are irregular, honeycombed, or poorly compacted, all unsatisfactory sections of joint shall be trimmed to expose an even, vertical, or sharply sloping surface for the full thickness of the course. Fresh mixture shall be racked uniformly against the joint, followed by rolling.

(8) Edges

The edges of the bituminous pavement shall be free from all irregularities and honeycombs and shall correspond exactly to the lines as shown on the Drawings.

(9) Bituminous Pavement on Bridge Deck

The bituminous pavement on the bridge deck shall be constructed in accordance with the required thickness as stated in the Bill of Quantities or shown on the Drawings. A tack coat shall be applied as described in Clause 504 and directed by the Engineer.

(10) Shoulders

After completion of the bituminous pavement, shoulders shall be formed to the lines and grades shown on the Drawings. The shoulder edge shall be coincident with the pavement edge.

(11) Tolerances

When measured with a 3 meters straight edge, deflection shall not be greater than 5 mm for each layer.

The thickness shall be controlled on the samples taken for control of compaction. The tolerances shall be within the range -10%, +20% of the thickness defined on the Drawings or as directed by the Engineer. For each working day, the average of all results shall be at least equal the required thickness.

If for two consecutive working days, more than 10% (ten per cent) of the measurements do not comply with these requirements, the work shall be stopped in order to examine and improve the methods and equipments used and if necessary substitute any defective equipment.

506.08 Sampling and Testing

(1) Sampling and Testing of Materials

All materials shall be approved by the Engineer prior to use in the work. Approval of the source does not mean that all material in the source is approved. Aggregates and bituminous materials shall be sampled at the source and/or job site and tested as frequently as deemed necessary by the Engineer. In general, bitumen shall be sampled once for each 100 tons.

A stripping test to check the suitability of aggregates shall be made in accordance with relevant clauses of these Specifications.

(2) Sampling and Testing of Mixtures and Pavements

Samples of the plant mixtures shall be taken at the plant and/or on the working site and tested as frequently as deemed necessary by the Engineer to determine if gradation, bitumen content and Marshall stability conform to the job-mix formula requirements and if the temperature is as directed. The testing of mixtures and pavement shall be in accordance with sub-clause 1012.04.

Suitable sized samples for the determination of the density, the composition and the thickness of the completed pavement shall be removed as often as deemed necessary by the Engineer. The Contractor shall repair the pavement where samples are removed at his expense.

(3) Performance and Expenses for Tests

All tests necessary to determine conformance with the requirements specified herein shall be performed by the Engineer.

If the deficiency in composition and/or density and/or thickness exceeds the requirements specified and/or smoothness exceeds the specified

tolerances, no payment shall be made for such areas of pavement until they are removed and replaced by the Contractor at the Contractor's expense.

It shall be the responsibility of the Contractor to take samples as and where required by the Engineer, to provide all necessary containers and wrappings and to dispatch to the Site Testing Laboratory, all the costs of which are deemed to be included in the unit rates entered in the Bill of Quantities.

(4) Inspection of Plant and Equipment

The Engineer shall have access at all times to all parts of the paving plant for checking the adequacy of the equipment in use, inspecting the operation of the plant, verifying weights, proportions, and character of materials, and checking temperatures being maintained in the proportion of the mixtures.

506.09 Measurement

The hot-mix bituminous concrete pavement will be measured by the square meters of the completed hot-mix bituminous pavement in place including both binder and wearing courses. The number of square meters of the completed bituminous pavement shall be determined by the length measured along the center line and upon the surface of the road or bridge, times the width as shown on the drawings, plus the areas of any widening on curves, turnouts and intersections authorized by the Engineer.

506.10 Payment

The accepted quantities of completed pavement of the different thickness will be paid for at the contract unit price per square meter.

No additional payment will be made for any thickness of pavement in excess of the thickness specified or shown on the Drawings.

Such payment shall constitute full compensation for preparing the surface of the base course, furnishing all materials, equipment, plant and tools; handling, mixing, manipulating, placing, shaping, compacting, rolling; and finishing; correcting unsatisfactory areas; and all labour and incidentals necessary to complete the work required by this Clause of these Specifications.

Payment will be made under:

	Pay Item	Pay Unit
E04.	Supply, preparation, spreading and compaction of Hot-mix Bituminous Concrete Surface Course of main road carriageway	
01	Asphalt Binder Course, 5 cm thick after compaction applied on prepared base	m2
02	Asphalt Wearing Course, 5 cm thick after compaction applied on prepared asphalt binder course of main road carriageway, prepared base course of shoulder for main road, prepared base course of approach road for overbridge and prepared bituminous treated base course of access road carriageway	m2
03	Asphalt Wearing Course, 8 cm thick after compaction applied on prepared concrete deck of main road bridge and overbridge	m2
04	Asphalt Wearing Course, 4 cm thick after compaction applied on prepared base course of footway of access road and approach road for overbridge	m2
05	Asphalt Wearing Course, 3 cm thick applied on prepared concrete deck of pedestrian bridge	m2

507 ROAD ANCILLARIES

507.01 Scope

This work shall consist of the construction of turfing and seeding, guardrails, footways, kerbs, road marking and permanent traffic signs in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the drawings or established by the Engineer.

507.02 Turfing and Seeding

(1) Turfing

The verges, islands of intersection and roundabouts and median strips shall be topsoiled and turfed in accordance with these Specifications and as shown on the drawings or as directed by the Engineer. Where required by the Engineer, scarification of the subsoil shall be carried out at the Contractor's expense.

The top soil stock-piled for re-use in accordance with relevant sub-clauses hereof shall be used.

The verges shall be defined as the surface between the outside shoulder's edge and the top edge of the embankment or side drain.

(2) Seeding

The embankment slopes shall be seeded in accordance with these Specifications and as shown on the Drawings or as directed by the Engineer. Where required by the Engineer, scarification of the subsoil shall be carried out.

Sowing of grass seed shall be carried out with an even distribution using the blend of seed, fertilizer and soil approved by the Engineer.

The rate of application of the seed shall be directed by the Engineer.

507.03 Guardrails

(1) General

Guardrails shall be installed as shown on the Drawings or as directed by the Engineer. The posts shall be spaced at a standard interval of 4 meters. Posts shall be plumbed. The top of the post shall be set to the design level with a tolerance of 2 centimeters.

The type of guardrail are "Beam Type Guard Rail".

(2) Materials

Materials shall meet the applicable requirements specified in sub-clause 913.04.

507.04 Footway

(1) General

Footway shall be constructed as shown on the drawings or as directed by the Engineer.

(2) Materials

Bituminous footway material shall meet the requirements specified in sub-clause 913.05. Base Course Material shall meet the requirements specified in sub-clause 906.02.

(3) Construction Requirements

(a) Earthwork

Earthwork shall meet the requirements of the applicable sub-clauses of Clause 300.

(b) Base Course

Base course shall meet the requirements of the sub-clauses of Clause 503.

(c) Placing Bituminous Footway Material

Bituminous footway material shall be placed on the compacted base course in a course as indicated so as to give the required depth when rolled. Compaction shall be accomplished by means of a hand operated or power roller of a type and weight acceptable to the Engineer. In areas inaccessible by the roller, hand tamping will be permitted. In any case, the bituminous footway material shall be uniformly compacted.

507.05 Kerbs

(1) General

Kerbs shall be installed as shown on the Drawings or as directed by the Engineer. The type of kerb is the "Precast Concrete Kerb".

(2) Materials

The materials used shall meet the requirements of the sub-clause of Clause 913.05.

(3) Construction Requirements

(a) Installation

The kerb shall be set so that the front top arris line conforms to the line and grade required. All spaces under the kerbing shall be filled with material conforming to the requirements of the material for base course. This material shall be thoroughly tamped.

(b) Joints

Kerbing shall be laid with joints as close as possible for precast concrete kerb. These joints shall be filled with mortar specified in sub-clause 913.05.

507.06 Road Marking

The paint shall be white road marking paint made by an approved manufacturer. The markings shall be continuous or intermittent lines as shown on the Drawings or as directed by the Engineer.

Uni-directional reflecting road studs which are called "cat's eyes" shall be fixed in place in accordance with the manufacturer's instructions, to the center line of the carriageway as shown on the Drawings or as directed by the Engineer. Unit-directional reflecting road studs to be used shall be equivalent to those shown on the Drawings and subject to the approval by the Engineer.

The road studs which are called "Chatter bars"shall be fixed in place in accordance with the manufacturer's instructions, adjacent to the ramp nose of acceleration lane of the entrance terminals as shown on the Drawings or as directed by the Engineer. Chatter bars to be used shall be equivalent to those shown on the Drawings and subject to the approval of the Engineer.

507.07 Permanent Road Signs

(1) General

All permanent road signs shall comply with the United Kingdom Ministry of Transport Roads signs Manual 1965 and any subsequent revisions in respect of size, shape and colour used. The size and shape of the symbols, letters and alphabet shall be as shown on the Drawings or as directed by the Engineer.

All permanent road signs shall be marked with the manufacturer's name or trade mark, and year of make. All signs shall comply with BS 873 1970 except as modified in this Specification or shown on the Drawings.

(2) Signs

Signs shall be manufactured from the following materials:

(a) Sheet Steel or Strip to BS 1149 or

(b) Cast Aluminium alloy to BS 1490 or

(c) Sheet Aluminium alloy or

(d) Extruded aluminium and extruded plank sections to BS 1474

and signs shall comply with relevant clauses of BS 873.

(3) Post and Fittings

These shall be in accordance with BS 873 1970 and of the following materials:

(a) Post

Tubular steel section of this size shown on the Drawings. The equivalent aluminium alloy section may also be used with the approval of the Engineer,

and post shall be painted with rust-proofed white.

(b) Fittings

Rust resistant steel or a wrought aluminium shall be used. All materials for fixing, brackets, clips, bolts, nuts, etc. shall be approved by the Engineer.

(4) Reflectorization

The colour of all permanent road signs with the exception of black and green will normally be reflectorized unless otherwise specified or ordered by the Engineer. Reflectorization shall be achieved by reflective sheeting material to meet the requirements of BS 873 1970.

(5) Mounting

A sign shall be erected at a distance from the edge of the carriageway as shown on the Drawings depending on the United Kingdom Ministry of Transport Roads signs Manual 1965, or as otherwise directed by the Engineer.

(6) Foundation

The foundation for permanent road signs shall be as shown on the Drawings, or as directed by the Engineer.

(7) Completion of Signs

The Contractor shall cut back trees and vegetation and shall not permit vehicles to be parked or material to be dumped so as to obscure the signs.

All signs shall be maintained in a clear and legible condition and washed down as directed by the Engineer.

507.08 Measurement and Payment

Measurement and payment for the items in this clause of these Specifications will be made as follows:

(1) Turfing and Seeding

Turfing and seeding will be measured by the square meter of turfing or seeding planted. Top soil for turfing will not be measured separately for payment, but the cost thereof shall be included in the cost of the turfing.

The accepted quantities of turfing or seeding will be paid for at the contract unit price per square meter of turfing or seeding planted.

Payment will be made under:

Pay Item		Pay Unit
E06.	Turfing and Seeding complete in place	
01	Turfing	m2
02	Seeding	m2

(2) Guardrails

Guardrails will be measured by the linear meter from center to center of end posts, except where end connections are made to masonry or steel structures, in which case measurement will be to the face of such structures.

End anchorages and terminal sections may be included in the quantities of guardrails of the respective type and not measured separately.

The accepted quantities of guardrails will be paid for at the contract unit price per linear meter for the type specified complete in place.

Payment will be made under:

Pay Item		Pay Unit
E07.	Supply and installation in place of Guardrails for embankment	m

(3) Kerbs

Kerbing will be measured by the linear meter along the front face of the section at the finished grade elevation.

The accepted quantities of kerbing will be paid for at the contract unit price per linear meter for the different kind and type of kerbing specified, and the base course will not be paid separately but the cost thereof shall be included in the cost of the kerb.

Payment will be made under:

Pay Item		Pay Unit
E08.	Precast Concrete Kerb complete in place	
01	Precast Concrete Kerb, type A	m
02	Precast Concrete Kerb, type B	m
03	Precast Concrete Kerb for bridge, type C	m

(4) Road Marking

Road marking will be measured by the square meter of traffic marking painted.

The accepted quantities of traffic marking painted will be paid at the contract price per square meter for traffic marking.

Payment will be made under:

	Pay Item	Pay Unit
E09.	Road Marking	
01	Road Marking, common	m2
02	Uni-directional Reflecting Road Studs "Cat's eyes"	nr
03	Road stud "Chatter Bars"	nr

(5) Permanent Road Signs

All signs will be paid for by numbers of each type. The rate per sign shall include for excavating in any material, backfilling and compaction to the foundations, disposal of surplus material, setting-out and erection and all materials necessary for the signs as specified, including supports, brackets, fittings and stiffering required, concrete and framework to the bases including placing and compacting, painting and finishes specified, and all labour, tools, plant, transport, supervision, overheads and any other costs associated with the provision and erection of the signs.

Payment will be made under:

	Pay Item	Pay Unit
E10.	Permanent Traffic Signs complete in place	
01	Permanent Traffic Sign, type A	nr
02	Permanent Traffic Sign, type B	nr
03	Permanent Traffic Sign, type C	nr

PART 6

STORM DRAINAGE WORKS

PART 6 STORM DRAINAGE WORKS

PART 6 STORM DRAINAGE WORKS

601 SCOPE

This work shall consist of the construction of ditches, pipe culverts including headwalls, wing walls and apron slabs, manholes, catch basins, shoulder inlets and other required storm drainage structures in accordance with these Specifications and in reasonably close conformity with the lines and grades established in accordance with the result of the practical survey for installation by the Contractor and approved by the Engineer.

602 DRAINAGE PROGRAMME

The Contractor shall submit to the Engineer for his approval immediately after the signature of the Contract a programme for the drainage works. The programme shall allow for completion of all drainage systems necessary for drainage during construction before Works are started, and shall show which drainage systems shall be constructed prior and after completion of the embankment so that the drainage systems are neither endangered nor damaged during construction of the embankment.

603 MATERIALS

Materials shall meet the requirements specified in Clause 914 of these Specifications.

Reinforced Concrete Pipe	914.01
Non-Reinforced Concrete Pipe	914.01
Joint Mortar	914.02
Reinforcing Steel	909
Precast Concrete Units	913.05

Classes of concrete and mortar to be used:

Foundation : Grade 15

Concrete bed : Grade 15

Reinforced concrete : Grade 25

604 CONSTRUCTION REQUIREMENT

604.01 Drainage Excavation

The Contractor shall excavate all drainage systems to the lines, levels, gradients and dimensions shown on the Drawings or as established by the Engineer.

Excavation for drainage systems shall be carried out in accordance with the requirements of Clause 300 of these Specifications.

Should excavations be executed to greater depth or dimensions than necessary through the incidence of boulders or through other cause, the Contractor shall backfill and make good, with approved materials thoroughly compacted, to the correct level and dimensions and to the approval of the Engineer.

The material excavated for drainage systems shall be, if suitable, set aside for use as backfill and if unsuitable or in excess run to waste.

604.02 Trench and Hole Excavation and Backfilling

The trench and hole excavation shall be of a size sufficient to enable the bottom to be compacted as required, the bed to be laid, the pipes and concrete to be placed accurately and proper backfilling and ramming to be carried out.

Where required the bottom of such excavations shall be compacted to not less than 95 per cent of the maximum dry density.

Where rock is met at the level of the intended bottom of the trench or hole, it shall be cut to a depth of 20 centimeters below this level and replaced with sand, granular material or other material to the approval of the Engineer.

The sides of excavations such as trenches and holes shall where required be timbered and shored to the satisfaction of the Engineer. The Contractor shall remain liable for any damage or injury consequent upon removal of timbering or shoring.

Where directed by the Engineer the timbering and shoring shall be left in excavations.

Trenches and holes shall be kept free from water until any works such as concrete or joints therein are sufficiently set; the Contractor shall construct any temporary drains that the Engineer may deem necessary.

Where seepage of water occurs in trenches or holes, bedding and backfilling shall be carried out using sand, granular material or crushed stones or other material as directed by the Engineer.

Material for backfilling shall be to the approval of the Engineer and shall be deposited in layers not exceeding 15 cm of loose material, compacted with power rammers, the moisture content of the material

being adjusted to facilitate thorough compaction. The density of each compacted layer shall not be less than 95 % of BSHMDD.

604.03 Ditches and Channels

Ditches shall be constructed to the cross section as shown on the Drawings or as established by the Engineer and the invert shall be finished smoothly to a steady longitudinal gradient of not less than 0.5 % and the fall shall, in all cases, be towards a culvert or turn out.

Where the longitudinal gradient is greater than 5 % or as shown on the Drawings or as directed by the Engineer, ditches shall be lined with the materials mentioned in sub-clause 913.05 precast concrete products or grouted riprap. Care shall be taken that the top edge of the concrete is laid to an even line, expansion joints filled with an approved bituminous compound shall be formed every 10 meters.

Concrete construction shall be carried out in accordance with Clause 400 of these Specifications. Precast or in-situ elements shall be of Grade 25.

All the stones for grouted riprap of ditches or channels shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjacent stones. The stones shall be laid perpendicular to the slope with ends in contact. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be chinked with spalls firmly rammed into place. The spaces between the stones shall then be filled with cement mortar. Sufficient mortar shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed.

Grout shall be placed from bottom to top and the surface swept with a stiff broom. After grouting is completed, the surface shall be cured as

specified for "Concrete" for a period of at least 3 days.

604.04 Bedding

The pipe, manhole and catch basin bedding shall be of crushed stone.

604.05 Laying Pipes

Pipes shall be placed on a bed and to the line and level as shown on the Drawings or as directed by the Engineer.

The method, tools for placing the pipes, joints to be used shall be to the approval of the Engineer.

A properly fitted plug shall be well secured at the end of each pipe already laid and shall be removed only when the next pipe line is being laid or on completion of the pipe line of culvert.

Where required by the Engineer bedding shall curve upward along the culvert centerline to correct for expected settlement and to insure tightness in the lower half of the joints.

The flow line of the pipes shall be within a range of 0.5 centimeters of the specified level shown on the Drawings or as directed by the Engineer.

The end of all pipes shall be neatly built into the walls and finished with cement motar specified in these Specifications. Jointed pipes shall be tested as directed by the Engineer.

The specified backfill material shall be brought up equally on both sides of the pipe first to the level of the center of the pipe line and then up to a height 30 centimeters above the top of the pipe barrel in layers each not more than 15 centimeters, and shall be carefully compacted for the full width of the trench with approved hand tools.

The backfilling thereon shall be carried out in accordance with sub-clause 302.03 of these Specifications.

604.06 Concrete

Concrete construction shall conform to the requirements for structural concrete mentioned in Clause 400 of these Specifications. Joints s shall be full mortar joints.

604.07 Shoulder Inlet

Shoulder inlet (Si) shall be of the structure shown on the Drawings and shall be installed at a designated interval and grade in the verge of the embankment sections as shown on the Drawings, and the location and grade of the shoulder inlet shall be subject to the Engineer's approval.

605 MEASUREMENT AND PAYMENT

Measurement and payment for these items will be made as follows:

605.01 Ditches

Ditches of different types and sizes will be measured by the linear meter of ditch excavated.

Excavation and placing of riprap surface shall be included in the quantities of ditches of the respective type and not measured separately.

The accepted quantities of different types and sizes will be paid for at the contract unit price per linear meter of ditches constructed.

Payment will be made under:

	Pay Item	Pay Unit
F01.	Ditch Channel and Drain Pipe complete in place	
01	Earthen Excavated Ditch type Ds-ED	m
02	Rock Surfaced Ditch type Ds-RS	m
03	Rolled Gutter type Ds-RG	m
04	Precast Concrete Ditch type Ds-Pu(A)	m
05	Ditto, Ds-Pu (B_1)	m
06	Ditto, Ds-Pu (B_2)	m
07	Ditto, Ds-Pu (B_3)	m
08	Concrete Ditch, type Ds-U(A)	m
09	Ditto, Ds (C)	m
10	Ditto, Ds (D)	m
11	Ditto, Ds (E)	m
12	Ditto, Ds (F)	m
13	Ditto, Ds (G)	m
14	Ditto, Ds (H)	m
15	Ditto, with cover Ds-$\bar{U}$ (A)	m
16	Ditto, Ds-$\bar{U}$ (C)	m
17	Ditto, Ds-$\bar{U}$ (F)	m
18	Ditto, Ds-L (A)	m
19	Ditto, Ds-L (B)	m

20	Ditto, Ds-L (C)	m
21	Ditto, Ds-L (D)	m
22	Concrete Ditch, type Dv-U	m
23	Shoulder Inlet type Si	nr
24	Relocated Waterway	m
25	Concrete Cover for side ditch in Box Culvert	m

605.02 Pipe Culverts

Pipe culverts of a different type and size laid will be measured by the linear meter in place from face to face of other structures such as headwalls, wing walls, apron slabs, inlets and/or outlets. Headwalls, wing walls and apron slabs for pipe culverts shown on the drawings will be separately measured by the numbers in place.

Headwalls of a different type and size will be measured by the number of each item in place.

Excavation, backfill, bedding, steel reinforcement, concrete form and concrete will not be measured for payment but the cost thereof shall be included in the cost of respective pay items.

The accepted quantities of pipe culverts will be paid for at the contract unit price per linear meter for the type specified complete in place.

The accepted quantity of headwall for pipe culvert will be paid for at the unit price per number for each type specified complete in place.

Payment will be made under:

	Pay Item	Pay Unit
F02.	Pipe Culvert complete in place	
01	Precast Concrete Pipe, type C-P(A)ø152	m
02	ditto, ø304	m
03	ditto, ø380	m
04	ditto, ø457	m
05	ditto, ø762	m
06	ditto, 1066	m
07	ditto, type C-P(B)ø304	m
08	ditto, ø380	m
09	ditto, ø457	m
10	ditto, ø533	m
11	ditto, type C-P(C)ø762	m
12	ditto, ø1066	m
13	ditto, type C-P(TWIN)ø1066	m
14	ditto, type C-P(C)ø609	m
15	ditto, ø685	m
16	ditto, ø914	m
17	ditto, type C-P(D)ø762	m
18	Miscellaneous, PVC pipe, ø179	m
F03.	Head wall for pipe culvert complete in place	
01	Type Hw-(A)	nr
02	Hw-(B)	nr
03	Hw-(C_1)	nr

04	Hw-(C_2)	nr
05	Hw-(C_3)	nr

605.03 Catch Basin, Inlet and Outlet

Catch basins, inlets and outlets of different types and sizes will be measured by the numbers in place.

Excavation, backfill, bedding, steel reinforcement, concrete form and concrete will not be measured for payment separately but the cost thereof shall be included in the cost of respective pay items.

The accepted quantities of catch basin, inlets, and outlets, etc. will be paid for at the contract unit price per each complete in place.

Payment will be made under:

F04. Catch Basin complete in place

01	type D$\bar{c}$-(A_1)	nr
02	D$\bar{c}$-(A_2)	nr
03	D$\bar{c}$-(A_3)	nr
04	D$\bar{c}$-(A_4)	nr
05	D$\bar{c}$-(A_5)	nr
06	D$\bar{c}$-(A_6)	nr
07	D$\bar{c}$-(A_7)	nr
08	D$\bar{c}$- (B_1)	nr
09	D$\bar{c}$- (B_2)	nr
10	D$\bar{c}$-(D)	nr
11	D$\bar{c}$-(K)	nr
12	D$\bar{c}$-(N_1)	nr

13	Dc̃-(N_2)	nr
14	Dc̃-(N_3)	nr
15	Dc-(C)	nr
16	Dc-(E)	nr
17	Dc-(F)	nr
18	Dc-(G)	nr
19	Dc-(H)	nr
20	Dc-(I)	nr
21	Dc-(J_1)	nr
22	Dc-(J_2)	nr
23	Dc-(J_3)	nr
24	Dc-(L_1)	nr
25	Dc-(L_2)	nr
26	Dc-(L_3)	nr
27	Dc-(M_1)	nr

F05. Inlet or Outlet complete in place

01	Inlet or Outlet for pipe culvert ø762, type A	nr
02	ditto, type B	nr
03	ditto, type C, H=1,40m	nr
04	Inlet for P.C.ø762 type C, H=1.60m	nr
05	ditto, type C, H=2.20m	nr
06	Inlet or Outlet for pipe culvert ø1066, type A	nr
07	ditto, type B	nr

08	Inlet for P.C.ø1066 type C, H=1,60m	nr
09	Inlet or Outlet for P.C.ø1066 ditto, type C, H=1.90m	nr
10	Inlet for pipe culvert (TWIN) ø1066	nr
11	Outlet for pipe culvert (TWIN) ø1066	nr

PART 7

MASONRY WORKS

PART 7 MASONRY WORKS

PART 7 MASONRY WORKS

701 GROUTED RUBBLE MASONRY

701.01 Scope

This work shall consist of the construction of grouted rubble masonry including concrete base in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the drawings or established by the Engineer.

701.02 Materials

The stone for rubble masonry shall be as specified in sub-clause 915.02 of these Specifications.

Concrete for rubble masonry base shall be of Grade 15 as specified in Clause 402 of these Specifications.

Mortar for laying the stone and pointing shall be of a mix specified in sub-clause 915.02, unless otherwise directed by the Engineer.

701.03 Construction Requirements and Construction Methods

(1) Shaping Stone

The stones shall be roughly squared on joints, beds and faces and all shaping or dressing of stone shall be done before the stone is laid in the wall.

(2) Excavation

Excavation for masonry works shall be made in accordance with 604.02 of these Specifications, and when masonry rests on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed.

(3) Concrete Base

The Concrete base of Grade 15 shall be constructed in accordance with the clauses of Clause 400 of these Specifications.

(4) Laying Stone

The masonry shall be laid to line and in course roughly levelled up and all course shall be laid with bearing beds parallel to the natural beds of the material.

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be clean and well moistened. All stones shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not less than 2 centimeters.

Whenever possible, the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth 5 centimeters before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joint or that used in pointing.

Vertical joints in each course shall break with those adjoining courses at least 15 centimeters. In no case shall a vertical joint be so located as to occur directly above or below a header.

(5) Pointing

The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least four days after completion. After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workman-like condition.

(6) Expansion Joint

The wooden expansion joint of 15 millimeters thick approved by the Engineer shall be placed at the interval of less than 20 meters or as shown on the drawings.

(7) Weep Hole

The polyvinyl chloride weep hole pipe of 4 centimeters in diameter shall be installed as shown on the drawings or as directed by the Engineer, and the weep hole pipes shall be neatly built into the selected backfilled layers.

(8) Backfill

Backfill shall be made as shown on the drawings or as directed by the Engineer in accordance with sub-clause 302.02 of these specifications.

(9) Sheathing

Sheathing shall consist of gravel, crushed stone or sand furnished and placed in layers against the inside faces of retaining walls, wing walls, backfaces of abutments in accordance with these Specifications and in reasonably close conformity with the requirements shown on the Drawings or as directed by the Engineer.

Sheathing material shall meet the requirements speficied in sub-clause 915.03 of these Specifications.

The sheathing shall form a continuous covering over the entire designated surface, extending from the elevation of the bottom of the weep holes and drains to the top of the wall, and it shall be so placed that mingling with the fill will be prevented. Unless specific thickness is shown or ordered, the layer of sheathing shall have a nominal total thickness of 30 centimeters.

701.04 Measurement and Payment

Grouted rubble masonry will be measured by the square meter of the surface of grouted rubble masonry of each type constructed.

Concrete base will be measured separately by the linear meter of the base of each type constructed.

Wooden expansion joints, weep hole pipes, excavation, sheathing and backfill with selected material will not be measured separately for payment, but the cost thereof shall be included in the cost of the grouted rubble masonry.

The accepted quantity of grouted rubble masonry will be paid for at the contract unit price per square meter of grouted rubble masonry of each type constructed.

The accepted quantity of concrete base will be paid for at the contract unit price of each type per linear meter of the base constructed.

Payment will be made under:

	Pay Item	Pay Unit
G01.	Grouted Rubble Masonry Complete in Place	
	01 Grouted Rubble Masonry for Embankment area, Type E	m^2
	02 ditto, but for Cutting Area, Type C	m^2
	03 ditto, but for Bridge Works, Type P	m^2
G02.	Concrete Base for Grouted Rubble Masonry Complete in Place	
	01 Concrete Base for Type E Masonry	m
	02 ditto, but for Type C Masonry	
	03 ditto, but for Type P Masonry	m

PART 8

LIGHTING INSTALLATION

PART 8 LIGHTING INSTALLATION

PART 8 LIGHTING INSTALLATION

801 SCOPE

The work covered by this Clause of these Specifications shall consist of the supply of all lanterns (luminaires) and lamps, poles and other supporting devices including basements, cables, switchgear, control devices and all necessary ancillary equipment together with the transportation, storage, assembly, erection, connection and testing of the same in order to supply a complete lighting system at Motorway Junction, and Pointe Aux Sable and Coromandel Interchanges in accordance with the details shown on the Drawings and in accordance with the Specifications.

An outline of the whole Lighting Installation work is indicated on the drawings.

802 RESPONSIBILITY FOR DESIGN AND MATERIALS

Items of equipment and parts shall have the manufacturers specifications agreeing with those of the Japanese Industrial Standard Institute, the U.S. Standards Institute, the American Society for Testing Materials, the American Association of State Highway and Transportation Officials, the National Bureau of Standards, the British Standards Institute, the British Institution of Electrical Engineers Regulations or other similar internationally recognised body. All work shall be done and all goods shall be made in strict accordance with Regulations, Ordinances and Statutory Requirements issued by the competent responsible authorities in Mauritius.

The Contractor shall be responsible for all necessary supplementary design and the coordinated functioning of all goods and constructions furnished under this contract, taking into consideration the outlined concept of the system in question as shown on the Drawings or Schedules/Lists or Remarks therein. All the component parts not detailed on the drawings shall be designed so as to ensure their proper coordinated functioning and operation. Unless otherwise specified all equipment shall be of the manufacturers standard models and shall include all recent improvements in design and materials. All materials used in manufacture and construction shall be of high quality and fully in accordance with the best modern practices.

The equipment offered and the work done shall be suitable for continued trouble-free operation under adverse climatic conditions of heavy rain, high humidity and intense sunlight. The equipment must be able to withstand over long periods ambient air temperatures varying from -20°C to a maximum of 40°C.

803 COMPLIANCE WITH MANUFACTURER'S SPECIFICATIONS

The Contractor shall ensure that the equipment and parts used will be entirely suitable for the work to be performed and that they will be manufactured to proper clearances and fit. He shall further ensure that the loading of equipment will under all normal circumstances not exceed the maximum load laid down or agreed in writing by the manufacturer.

The Contractor shall be responsible for the inspection of all equipment and parts before their incorporation in the works to ensure that they comply with the Specifications and that they are not defective in any way as regards materials or workmanship.

At any stage of the work the Engineer shall be given the opportunity to inspect all materials and workmanship or parts thereof. The Contractor shall provide the assistance necessary for this purpose and make such non-destructive tests as the Engineer requires at no extra charge.

804 MAINTENANCE PERIOD

All repairs and replacements required during the Maintenance Period stipulated in the Contract shall be carried out with dispatch and an adequate supply of spares shall be available for this purpose. Repairs shall be included in the unit rates.

805 DESIGN

805.01 General

This sub-clause of the Specifications details the major pieces of equipment required for the definite works referred to in these Specifications and on the Drawings.

(1) System Voltage

The medium voltage distribution will be at 400/230 volts, 3 phase, 4 wire, 50 Hz solidly earthed neutral.

(2) Electrical Distribution

The approximate locations of the main Distribution Switch Board and the distribution arrangements from the Switch Board are shown on the Drawings.

805.02 Switch Boards

(1) Cubicle

The distribution Switch Board shall be equipped as detailed on the Drawings, complete in all respects and ready to set to work. Complete earth continuity shall be maintained between all of the component parts of the Switch Board and provision made for the efficient bonding to earth of the incoming and outgoing cable armouring. The cubicle shall be of robust construction of cast iron or steel, completely weather-proof, suitable for front access and fitted with single or double doors dependent on the width of the unit. The doors shall preferably be of cast iron but fabricated mild steel doors will be considered. The doors shall be fitted with a cylinder lock as the Engineer may approve.

The cubicle shall be provided with suitable cast iron or steel bases designed for plinth mounting generally as shown on the Drawings. The cubicle shall be painted on the outside in accordance with the requirements of these Specifications. The inside of the cubicle shall be suitably primed and finished cork sprayed.

The cubicle shall have an adequate ventilation bearing in mind the high temperature and humidity. Ventilation openings shall be provided with fine mesh screens or filters to render the cubicle completely vermin and insect proof.

(2) Anti-Condensation Heaters

The cubicle shall be equipped with anti-condensation heaters which will be required to be continuously in service during periods of high humidity and suitable automatic switching by humidistat shall be provided. The heaters shall be connected on the "live" side of the main incoming switch and a suitably rated isolating miniature circuit breakers and a "heater supply available" pilot lamp provided. The heaters shall have minimum heat dissipation necessary for the effective

prevention of condensation. A label shall be fixed in a prominent position inside the cubicle reading "Isolate heater circuit before commencing maintenance". The inscription shall be in both English and French.

(3) Potential and Current Indicators

All feeder pillars shall be equipped with potential and current indicators connected on the "live" side of the main incoming switch.

(4) Moulded Case Circuit Breakers

Moulded case circuit breakers shall be single or triple pole as required and rated in accordance with the duty requirements shown on the Drawings. They shall be fitted with thermal magnetic tripping with inverse time delay protection against sustained overloads, and instantaneous tripping on heavy overload or short circuit conditions, and have trip free features. The magnetic tripping shall be adjustable over a wide range. The moulded case circuit breaker shall also provide earth leakage protection which if not an integral feature, may by provided by an external earth leakage current sensing device operating a shunt trip. Under voltage release is not required. The moulded case circuit breaker shall have the ON and OFF position clearly marked and facilities shall be provided for padlocking in the OFF position. The moulded case circuit breaker shall comply with BS 3871 Part 2 or equivalent standard as the Engineer may approve.

(5) Contractors

Where shown on the exhibited Drawings, lighting shall be controlled by time switch operated electro-magnetic contactors. The contactors shall be 400 volt triple pole, air break with a bolted removable link in the neutral conductor, have a 230 volts control circuit, Category AC4, Class 0 mechanical endurance and rated for uninterrupted duty in accordance with BS 775.

(6) Time Switchs

Synchronous time switches for connection in the contactor controlled circuits shall be of the solar dial type with spring reserve and provided with a facility for manual switching locally. Separate terminals shall be provided for the motor and switching circuits. The time switch motor shall be for use on 230 volts, 50 Hz supply and connected on the "live" side of the contractor that it controls. A protective fuse shall be provided in the line connection to the motor.

(7) Labels

Cubicle and distribution board shall have designation and identification reference number labels and all three phase equipment shall have "DANGER - 400 VOLTS" labels, fixed by means of screws on the front in prominent positions. Distribution boards shall, in addition, be provided on the inside of the front cover with a circuit chart. All labels shall have the legend engraved in English or French; labels on internally fixed equipment being of laminated plastic material engraved to give black (or in the case of the "danger" labels, red) lettering on a white background and labels on externally fixed equipment e.g. cubicle, shall be in stainless steel with the engraved inscriptions made out in black or red paint as appropriate.

(8) Painting

Where not finished bright, the work shall be thoroughly cleaned, scraped and wire brushed to remove all rust and loose scale and cleaned to remove dirt and grease. It shall then immediately be primed with one coat of red oxide primer followed by one coat of flat undercoating and two coats of best quality anti-corrosive finishing paint of shade No. 694, BS 381C or equivalent standard. Sufficient paint shall be provided for the Contractor to make good any damage to works with applied finishes on completion of erection at Site. Cellulose paints will not be accepted.

805.03 Distribution and Circuit Cables

(1) Cables

Mineral insulated copper clad cables with high temperature grade PVC sheath overall shall comply with BS 6207 or equivalent standard the Engineer may approve and shall be 600 volts grade. Seals shall be of the cold, screw-on pot type and all necessary glands, gland shrouds, seals, compound, insulated sleeving necessary for the proper termination of the cables shall be provided. Wedge type pot seals will not be accepted.

The cables for use inside lighting columns shall be multicore PCV insulated and PCV sheathed, 600/100 volts grade cables manufactured in accordance with BS 6004 or equivalent standard that the Engineer approves.

(2) Conduits and Fittings

All conduits shall be Class B, heavy gauge electrically seam welded, hop dip galvanised and screwed in accordance with BS 31 and BS 4568 or equivalent standard the Engineer may approve. Conduits smaller than 20 mm diameter shall not be used.

All conduit and adaptable junction boxes shall be of malleable cast iron, hop dip galvanised. Covers shall be galvanised malleable cast iron secured by cadmium plated brass screws.

Conduit or adaptable junction boxes shall always be used in place of elbows or tees, but factory made large sweep normal bends will be permitted. Otherwise, all conduits shall be "set" on site during installation.

Saddles shall be galvanised distance type for single conduits or multi-way spacer bar pattern as required.

All locknuts shall be circular, milled edge type, manufactured from steel and sheradized and all bushes shall be brass turned from solid bar.

805.04 Road Lighting

(1) General

The installation provides for the automatic control of the road lighting by means of solar dial type time switches located in the distribution switch board. The distribution to the road lighting circuits is from switch board equipped and located generally as shown on the Drawings.

(2) Illumination Level

The carriageway shall be illuminated to an average level of more than 21 lux.

(3) Road Lighting Columns

All road lighting columns shall be fabricated in steel, as shown on the Drawing, be of circular section with the base section designed for the accommodation of the lamp control gear, single 2300 or 2800 mm outreach bracket arm or arms inclined at an angle of 5 degrees from the horizontal and positioned to give a lantern mounting height of 10 or 12 meters above ground level and have an additional standard root for installation in the ground as shown on the Drawing.

(4) Cable Access

The roof of each column shall be constructed as shown in the Drawings or instructed by the Engineer in order to allow cables to loop in and out at a depth of 600 mm below ground level.

(5) Finish and Labels

The external surfaces of the colums shall be shot-blasted to remove all rest and scale and hot zinc sprayed in accordance with BS 729 or equivalent standard. The internal and external surfaces of all underground sections shall be treated with an approved bituminous coating.

All lighting columns shall bear not less than 70 mm square of identification label and the details of English or French inscriptions required shall be supplied by the Contractor subject to the approval of the Engineer.

(6) Road Lighting Lanterns

The road lighting lanterns shall be of the weatherproof, totally enclosed semi-cut-off type shown in the material list on the Drawing or of equivalent quality, suitable for fixing to the associated column bracket arm, side entry, and arranged to accommodate mercury lamps specified on the Drawing or of equivalent quality.

(7) Earthing

Complete earth continuity shall be maintained between the component parts of the columns, lanterns, cut-outs conduits and distribution boards. The columns and distribution boards shall be provided with an efficient earthing terminal to which the incoming cable earth core and cable armouring shall be bonded and connected to earth electrode rods as shown on the Drawings or in such manner as the Engineer may approve.

The earth electrode rods shall be steel cored copper covered, of not less than 20 mm diameter, extendable type, complete with hardened driving tips and driving caps. At each electrode position, there shall be two rods each driven to a depth of not less than 6 meters

and connected in parallel. The top of the earth rods forming each electrode shall be enclosed in a concrete inspection pit with heavy duty cover incorporating a lifting device.

806 CONSTRUCTION REQUIREMENTS AND CONSTRUCTION METHODS

806.01 General

(1) General Tools

All tools, lifting tackle, cable drum jacks, scaffolding, staging, plant equipment and all things necessary for the off-loading of all plant and equipment from delivery transport, handling about the Site, erection, completion and testing of the whole of the works shall be provided by the Contractor. In addition, all nuts, bolts, screws, rawplugs, clamps, fixing, and supports including angles, channels and other steelwork required for the support of plant and equipment, necessary for the complete and satisfactory installation and operation of the whole of the Works shall be provided by the Contractor and included in his rates and prices.

(2) Excavation

All excavation necessary for the installation of plant, equipment, cables and ducts, shall be deemed to be included in the rates and prices which shall include:

(a) Increases in bulk

(b) Excavation in whatever ground may be met with including consolidated hardcore but excluding hard rock or concrete.

(c) Getting out roots, drains, pipes and all other minor construction.

(d) Hand or machine digging

(e) Timbering or other temporary supports to sides of excavation and additional excavations required for timbering and subsequent backfilling.

(f) The location and protection of cables, drains, pipes and other service obstructions which are required to remain in-situ.

(g) Keeping excavation free from water from whatever cause arising, by pumping, baling or as directed.

(h) Trimming, grading, levelling and compacting bottom of excavations.

(i) Part return fill, ram, removal and disposal of surplus excavated material within the site area, or removal to tip, as directed by the Engineer.

(j) Double handling where necessary in connection with removal and disposal of excavated material.

(3) Setting Out

The Contractor shall be entirely responsible for all setting out and for the accuracy thereof.

The Contractor shall give the Engineer at least 24 hours prior notice in writing when he intends to set out, or fix levels, for any part of the Works to enable the Engineer to arrange for checking the same. Work shall be suspended where necessary during the checking and the Contractor shall carefully preserve any marks made by the Engineer. Such checking shall not relieve the Contractor of his responsibilities or liabilities under the Contract.

(4) Location of Equipment

Before commencing on any section or part of the Works, the Contractor shall confirm with the Engineer at the site the exact location of distribution boards, lighting poles, lighting fittings, switches and all other apparatus being supplied and installed, together with the routes of surface run and underground cables to be installed under this Contract.

(5) Existing Underground Service

The Contractor shall, before commencing on any section of the Works, confer with the appropriate authority to establish the approximate locations of any existing underground high and medium voltage cables, telephone cables, water mains, drainage or any other services and carry out such excavations as are necessary to establish the exact location of these services and provide suitable above ground markers so as to minimize the risk of accidental damage to them. The rates and prices entered in the Bill of Quantities shall be deemed to include all costs incurred by such site investigation.

The Contractor shall ensure that no damage is caused to existing underground services by his own operations and those of his sub-contractors during the execution and maintenance of the Works. Works and services damaged by the Contractor or his sub-contractors shall be repaired or renewed to the satisfaction of the concerned authorities in Mauritius and the cost of all remedial works shall be borne by the Contractor.

(6) Damage to Works

If, from any cause whatsoever, the works' applied paint finish on any of the plant and equipment is damaged prior to the taking over of the completed installations by the Employer, the Contractor shall make good the damage to the same standard as the original works applied finish, including rubbing down and the application of the primer, undercoat and finishing costs.

806.02 Switch Boards

(1) Cubicle

The cubicle, arranged for plinth mounting, shall be bolted down and the Contractor shall be responsible for levelling the cubicle, grouting and tightening the holding down bolts.

Wall mounting switch boards shall be securely fixed at a uniform height above floor level to the centre shown on the Drawing.

806.03 Cable and Conduits

(1) Distribution and Circuit Cables

The distribution and circuit cables shall be installed in ducts where provided or otherwise laid directly in the ground on the routes indicated on the Drawings. Cables laid underground shall be at a level to give a minimum cover of 500 mm. Where cables follow the same route they shall be laid in a flat formation.

Where cables are installed underground, the cable excavation shall be 75 mm deeper and 150 mm wider than actually required to accommodate the number of cables and a 75 mm thick sand bed shall be laid before any of the cables are laid. On completion of the installation of any cable or group of cables in a section of the trench, the cables shall be backfilled with sand to give a minimum 75 mm of cover to the largest cable and 75 mm of sand on both sides of cables and topped off with suitable interlocking concrete cable tiles. The sand shall comply with BS 1200 and shall be salt free. Cable tiles shall be inscribed "DANGER ELECTRICITY". The completed installation may then be backfilled with excavated material after removal of all large or sharp rocks and stones. The prices entered on the Bill of Quantities shall be deemed to include the costs of excavation, supplying and laying sand and cable tiles and all other costs in connection with the installation of cables underground.

(2) Temporary Protection of Cables

Where the Contractor has laid cables and is not able to install the protective soft sand and cable tiles due to his own programme of

working, he shall ensure that the cable and the cable ends are adequately protected against physical damage and interference. The Contractor shall obtain the approval of the Engineer to his proposed method of providing temporary protection to installed cables. Under no circumstances shall the Contractor leave exposed cable ends unsealed. Should the cables suffer damage through non-compliance with the requirements stated above the Contractor shall replace the whole of the damaged cable at his own expense.

(3) Cable Route Markings

The Contractor shall supply and securely fix an approved type of cable marker generally at 30 meter intervals along the route of underground cables and at closer intervals as necessary to clearly show any change of direction of the cables, which shall be subject to the approval of the Engineer.

(4) Continuous Length

As far as is practicable, all cables shall be installed in one continuous length between the two points of connection without any straight through joints. Where through joints are unavoidable due to maximum manufacturing lengths being insufficient for the route length of cable required, the joint shall be made using an approved type and manufactured through joint box and an earth bond shall be provided externally to the box to ensure a positive bond between the cable armouring. It is intended that such through joints as are necessary be housed in inspection pits. The Contractor shall, therefore, submit his proposed locations for through joints in sufficient time for the Engineer to prepared detailed drawings for the construction of the inspections pits.

(5) Cable Terminations

All cable terminations shall be made in the approved manner using the gland provided on the equipment and the cable armouring efficiently bonded in an approved manner to the earthing terminal or earth bar provided on the equipment. The Contractor shall ensure that the plastic shrouds are fitted in every case. The Contractor shall supply all necessary lugs and other jointing materials to complete the cable terminations.

All persons employed to make terminations on PVC cables shall have attended a course of instruction and each person shall demonstrate to the Engineer his ability to make a satisfactory cold seal termination before commencing work on the Site. The termination of the PVC cables shall be carried out with the ring type termination glands to the required diameter of the cable and cold screw-on pot seals utilizing the recommended sealing compound. Neoprene sleeving for the tails shall be applied in the manner recommended by the manufacturer and all neoprene tails shall be marked with appropriately coloured PVC phase tapes. PVC shrouds shall be provided at all terminations.

The Tender price shall include all cable fixings, cleats, labels and markers and any necessary fabricated support brackets where cables rise out of trenches or ducts at switchgear or equipment.

(6) Conduits

Where conduits are installed they shall be run as far as possible in straight or symmetrical lines with easy sets or large sweep normal bends. All joints, connections and terminations of the conduit shall be screwed and care shall be taken when installing conduits to ensure that the threads are clean, as also the interior of the conduit fittings, to provide good electrical continuity. All exposed threads shall be painted with zinc rich paint immediately after conduits have been erected.

All conduit ends shall be cut square and reamed to remove burrs. Threads shall be accurately cut with sharp dies and shall be screwed fully home into couplers and spout outlets.

Where conduits are terminated at cable entry plates of distribution boards, or other equipment and accessories not provided with screwed spouts, the connections shall be made by means of a machined face galvanised screwed coupler and hexagon male thread smooth bore brass bush passing through a clearance hole and with a cadmium plated spring compression washer inserted under the head of the bush to ensure permanent low impedance earth continuity.

Generally conduits are to be built into the structure and concealed. Where surface fixings are approved conduits shall be supported by distance type or spacer bar saddles at not more than 1.5 meter centres.

Not more than two 90 degree bends shall be installed between adjacent cable draw points and an ample number of through draw-in boxes shall be inserted in long runs.

All conduits shall be swabbed through before wiring is commenced and cables shall not be drawn into any conduit until that section of the conduit installation has been completed and satisfactorily tested for earth continuity.

806.04 Lighting

(1) Road Lighting Poles

The road lighting poles shall be erected on the concrete base which details are shown in the Drawings. The erection shall be made at least seven days after the base concrete is places. The rates and prices entered in the Bill of Quantities shall include the cost of excavation, concrete haunching, and any other works which are required therefore.

The Contractor shall ensure that the bracket arms of the road lighting pole are set at right angles to the center line of the carriageway.

The control gear compartment access door shall be located in a convenient position and arranged so that maintenance personnel are not in danger from passing traffic.

(2) Painting after Erection

Road lighting poles and all other equipment shall be painted after completion of erection generally in accordance with the appropriate requirements the Engineer may approve.

806.05 Earthing

(1) General

The general requirements for the earthing systems are shown on the Drawings. The whole of the lighting installations shall be efficiently earthed in accordance with the requirements of this Specification to the approval of the concerned authorities in Mauritius.

(2) Cubicles

A main earth electrode is required at each cubicle. In each case, the electrode shall comprise not less than two 20 mm diameter steel cored copper earth rods with hardened steel tips and driving caps, each at least 6 metres in length and driven in the locations shown on the Drawings, or such other locations as may be necessary to achieve satisfactory earthing. The Contractor shall include in his rates and prices for carrying out any necessary tests to establish the acceptability of these locations. Exact positions shall be agreed with the Engineer at Site with due regard to the presence of underground services. The resistance to earth to each electrode shall not exceed

500 OHM and if necessary, the Contractor shall drive sufficient number and length of additional earth rods to reduce the electrode earth resistance so that it does not exceed the maximum specified above.

The top of the earth rods forming each electrode shall be not less than 200 mm below finished ground or paving levels and the rods and earth lead connection shall be enclosed in a concrete inspection pit with a heavy duty cover incorporating a lifting device. The Contractor shall include the supply and installation of the inspection pits and covers in his rates and prices.

(3) Lighting Poles

All road lighting columns shall be connected to the earths by means of the earth core and armour of the circuit cables. Additional earth electrodes shall be driven at intervals and connected to selected lighting columns as shown on the Drawings. The final location of these additional electorodes will be determined on Site from tests carried out by the Contractor in accordance with the requirements for cubicle earths specified in these Specifications.

807 INSPECTION, TESTING AND COMMISIONING

807.01 Power to Inspect and Test at Works

The Engineer shall:

(a) have access at all reasonable times to the works of the Contractor and his sub-contractors,

(b) have the power to inspect, examine and test the materials and workmanship of the work, and the completed work, and

(c) be at liberty to reject all or any materials, workmanship or work not in accordance with the Contract, advising the Contractor in writing of the grounds for such rejection.

807.02 Independent Tests and Analyses

The Engineer shall:

(a) be at liberty to have any materials tested and/or analysed by an independent firm to be appointed by the Engineer, and

(b) call upon the Contractor to pay all expenses incurred in respect of work found to be defective, of inferior quality, adulterated or otherwise unacceptable.

807.03 Cost of Independent Tests

The Contractor shall:

(a) afford the Engineer or his Inspector all reasonable facilities for inspecting, examining and testing the work,

(b) bear the entire cost of and incidental to testing whether at his own or his sub-contractor's works or on Site, and the cost of providing and forwarding test pieces or drillings or other samples required by the Engineer for independent test or analyses-

(c) give such reasonable notice to the Engineer of the progress of the work as will permit the inspection, examination and testing and, in particular, give the Engineer adequate advance warning of when it is proposed to carry out any of the tests described hereafter, to enable him to attend such tests,

(d) replace free of charge any work rejected by the Engineer,

(e) not prepare any work for shipment until it shall have been passed by the Engineer, but no such approval shall relieve the Contractor from his liability to complete the work in accordance with the Contract,

(f) arrange for all equipment and materials listed in the Schedules and Bills of Quantities to be routinely tested at the maker's Works in the manner laid down in the appropriate Japanese Industrial Standard or British Standard or other approved specification and in the presence of the Engineer's Inspector, and

(g) provide four copies of Test Certificates showing readings and details of the tests, signed and dated by the Engineer's Inspector at the time of inspection, to be submitted to the Engineer for approval.

807.04 Installation and Commissioning Tests

The Contractor shall, after the plant is erected, installed and connected, carry out on site all mechanical and electrical commissioning tests necessary to establish to the approval of the Engineer that all plant and accessory and ancillary equipments are complete, operating satisfactorily and comply in all respects with the performance and operating requirements and with the Standards and Regulations specified.

807.05 Rectification of Defects and Re-Testing

In the event of the commissioning tests revealing any defect in the installation or the plant, or failure of the plant to achieve the specified performance, the Contractor shall immediately put in hand all necessary measures to rectify the defects and all costs involved in such rectification shall be borne by the Contractor. Any plant or equipment replaced due to defects observed during commissioning shall be subject to such further commissioning tests as may be necessary to establish suitability.

The Contractor shall provide all of the labour, testing equipment, instruments and materials required to carry out the Works and Site testing and commissioning. After completion of tests, certificates in quadruplicate shall be provided by the Contractor, showing details and readings of the tests for the Engineer's approval.

808 PROTECTION AND PACKING FOR SHIPMENT

808.01 Protection and Packing

After the Contractor has received the Engineer's agreement that the work may be prepared for shipment, the Contractor shall:

(a) apply two coats of best quality lacquer or other approved preparation to all bright or turned parts, after cleaning.

(b) pack the work in parts convenient for shipping.

(c) fix heavy pieces with rings or hooks rivetted on where necessary to facilitate lifting.

(d) mark the position for slings on heavy pieces required to be slung.

(e) take off and efficiently pack or protect projecting pieces of equipment shipped loose.

(f) pack in metal lined cases all bright parts and other work liable to corrosion, linings soldered airtight. Alternatively, tongued and grooved felt-lined cases may be used.

(g) pack bolts, nuts, washers etc., of different sizes in separate canvas bags, each labelled to show contents, before packing in cases.

(h) pack cables in suitable cases or on suitable drums. Where cables of the same size and type are manufactued in continuous lengths, they may be wound on the same drum providing full details of each individual length of cable are marked on the drum.

(i) before winding on drums the cables shall be sealed to prevent the ingress of moisture and foreign bodies.

(j) the cables shall be drummed so that the rotation of the colour scheme at the running end is clockwise. An arrow shall be painted on the drum to show the direction to that in which the outer end of the cable points.

(k) all cable drums shall be of robust manufacture lagged with strong closely fitted battens so as to prevent damage to the cable during transit or storage and all spindle holes shall be suitably reinforced with sheet steel plates.

808.02 Other Requirements

(a) The following information shall be painted in black on white background on both sides of each drum and embossed on metallic labels:

- Size of Cable
- Number of Cores
- Length
- Item Numbers
- Cable Numbers
- Gross Weight

(b) Pack small parts and fittings in cases weighing not over 500 kg when full. The weight of cases containing large pieces is not limited provided the case are strong enough for lifting and transporting without injury, if practicable, no piece or package shall exceed 6,000 kg in weight.

(c) Brand, cut or paint on each case or cable drum of package the gross and net weights and shipping marks, if necessary the marks may be embossed on metallic labels.

(d) Be entirely responsible for the sufficiency of the painting, protecting or preserving, packing cases, and branding and marking of same, to ensure delivery of the work on Site free from injury or mistake, notwithstanding any exercise by the Engineer or the power of superintendence.

809 MAINTENANCE OF PLANT AND EQUIPMENT

809.01 Maintenance Period

In accordance with Contract, the Maintenance Period for the works included under this Clause of the Contract is twelve months from the date of the Engineer's certificate of completion.

809.02 Tools

At the time of take over the Contractor shall hand over to the Employer complete sets of tools, spanners, gauges and other appliances necessary for the efficient maintenance and servicing.

Each set of tools shall be contained in a mild steel box with an approved make of padlock. Each tool box shall be clearly marked to indicate the plant or installation for which the contents are intended and a detailed list of tools which it is proposed to supply shall be included with the tender.

809.03 Spares

The Contractor shall enter in the Bill of Quantities for Definite Works his prices for the supply and delivery of spare parts. Where the Contractor is requested to submit a list of spare parts he recommends should be held on site, he shall submit the list in the form of a separate letter accompanying his tender.

Such spares as may be ordered will be subject to the same tests and conditions as for similar equipment being supplied as part of this Contract. All spares shall be packed in cases suitable for storing the equipment over a period of years without deterioration.

810 MEASUREMENT

Cubicles will be measured for payment by number of each type of cubicle including all the components specified on the Drawings or equivalent as the Engineer may approve, in accordance with the requirements of these Specifications, and any other works complete in place and accepted.

Poles will be measured for payment by number of each type of pole together with lantern (luminarie), lamps and any other components including fittings necessary to fix the pole to the base or to the structure, or equivalent as the Engineer may approve, in accordance with the requirements of these Specifications, complete in place and accepted.

Cables will be measured for payment by linear meters of each type of cable as shown on the Drawings, or equivalent as the Engineer may approve, including laying, connection and any other incidental works.

Earth electorodes shown on the Drawings or equivalent as the Engineer may approve will be measured for payment by number of each type including necessary works complete in place and accepted.

811 PAYMENT

The work measured as provided above shall be paid at the Contract unit price for each item, such price and payment constituting full compensation for furnishing all materials erection and testing, including labour, equipment, tools and incidentals necessary to complete the work.

Any materials and work necessary for satisfactory completion of the installation which are not specifically mentioned in the Bills shall be deemed to be included in the items shown.

PART 9

MATERIALS

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901 QUALITY OF MATERIALS

All materials used in the Works shall be of the qualities and kinds specified and shall be approved by the Engineer. When required they shall comply with the requirements, of the current amended editions, at the date of invitation to tender, of the British Standards (hereinafter abbreviated to BS) published by the British Standards Institution, or AASHO and ASTM Specifications as specified in these Specifications. All materials may be checked both at the source or on Site and approval of any material at its source does not necessarily imply that it will be approved on site.

All materials shall be delivered on to the site in sufficient time before they are required for use in the Works, so that such samples as the Engineer may wish are taken for testing and approval, and the Contractor shall furnish any information required by the Engineer of the materials.

No materials of any description shall be used without prior sanction by the Engineer.

Samples of the approved materials will be retained by the Engineer until the completion of the Contract. The Contractor shall provide suitable labelled boxes or bags for the storage of these samples.

Materials used in the Works shall conform to the samples approved by the Engineer.

902 APPROVAL OF SOURCE OF SUPPLY

Before ordering any materials, the Contractor shall submit, for the approval of the Engineer, the name of the Manufacturer of all items to be used in the Works and the source of supply of all materials to be used. The approval in writing of the Engineer shall be obtained before relevant items are obtained. The information regarding the names of suppliers may be submitted at different times, as may be convenient, but no source of supply shall be changed without the Engineer's prior approval.

Two copies of each order for materials are to be delivered to the Engineer and if any variation from the standard or type of materials is subsequently found necessary it shall be approved in writing by the Engineer.

903 DEFECTIVE MATERIALS

All materials which do not comply with the requirements of the Specifications will be rejected and all such materials, whether in place or not, shall be immediately removed from the site by the Contractor at his own expense.

904 HANDLING AND STORAGE OF MATERIALS

904.01 General

The Contractor shall make his own arrangements for the storage space and yards.

All materials for use in the Works shall be handled with due care and whenever not in immediate use, stored or stockpiled as specified below or as directed by the Engineer.

904.02 Storage of Cement

Cement shall be stored in well ventilated, watertight buildings with floors raised 50 cms above ground level and no cement shall be within 15 cms of the sides of the buildings to ensure circulation of air. Each consignment shall be kept separately and the contractor shall use the consignments in the order in which they are delivered on site. When being conveyed to the site in lorries or other vehicles, they shall be properly covered with tarpauling or other effective waterproof coverings. Cement which has become unsuitable through absorption of moisture shall be rejected and removed from the site by the Contractor at his own expense.

Each consignment of cement shall be kept separate, identified and used in order of delivery.

904.03 Stockpiling of Aggregates

Approved aggregates shall be stockpiled at approved locations; prior to stockpiling, the site shall be cleaned, levelled and well drained by the Contractor, who shall if required by the Engineer, also lay suitable hard surfacing.

Special care shall be taken to avoid segregation, contamination and mixing of different classes of aggregates.

904.04 Storage of Reinforcing Steel

Reinforcing steel shall be stored on wooden blocks so as to prevent sagging. Bars shall be stored in separate lots according to diameter and quality.

904.05 Bulk Storage of Bitumen and Cement

The Contractor may use bulk storage for bitumen and cement provided he can satisfy the Engineer that the capacities are adequate.

905 MATERIALS FOR EMBANKMENT

The materials shall comply with the following requirements:

- Plasticity index: not more than 25%
- Maximum size: 100 mm
- CBR value after 4 days soaking, at 95% of the BS Heavy Maximum Dry Density: not less than 10% (CBR specimen prepared at BS Heavy Optimum Moisture Content ±2%).

906 AGGREGATE

906.01 General

The stone for use in the works shall be obtained from approved quarries or stockpiles of boulders of basalt operated by the Contractor or by an approved sub-Contractor and consist of hard, tough, heavy, compact basalt, or other approved rock washed before crushing if necessary, broken, screened and graded as specified, to the satisfaction of the Engineer and free from flat, flaky, elongated, soft or decomposed pieces, excess dust and any dirt or acids or other deleterious substances.

Aggregates for different purposes are classified hereafter.

906.02 Aggregate for Subbase

The aggregate for subbase shall comply with the following requirements:

Los Angeles Value shall not exceed 30.

Sand Equivalent Value shall be more than 40.

Grading shall be within the specified limits required in Clause 503.

906.03 Aggregate for Bituminous Treated Base Course

The aggregate for bituminous treated base course shall comply with the requirements of sub-clause 906.04.

906.04 Aggregate for Hot-mix Bituminous Concrete Pavement

(1) Coarse Aggregate

Coarse aggregate (retained on the No.8 sieve) shall be basalt crushed stone, and shall conform to the quality requirements of relevant British Standard except that the sodium sulfate soundness loss shall not exceed 9 per cent or the magnesium sulfate soundness loss shall not exceed 12 per cent. The coarse aggregate shall be of such gradation that when combined with other required aggregate fractions in proper proportion the resultant mixture will meet the gradation required under the composition of mixture for the specific type under contract. Only one kind shall be used on the project except by permission of the Engineer.

(2) Fine Aggregate

Fine aggregate (passing the No.8 sieve) shall consist of crushed basalt sand, and shall conform to the quality requirements of relevant British Standard. Fine aggregate shall be of such gradation that when combined

with other required aggregate fractions in proper proportion, the resultant mixture will meet the gradation required under the composition of mixture for the specific type under contract. Coral sand shall not be used.

(3) Gradation

The several aggregate fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend meets the grading requirements shown in the sub-clauses of Clause 505 and 506.

(4) Filler

Filler (portion of material passing No.200 BS Sieve) shall consist of Portland cement or dust of crushed basalt.

906.05 Aggregate for Concrete

(1) Coarse Aggregate

Coarse aggregate for concrete shall conform to the requirements of BS 882. Coarse aggregate shall be furnished in two separated sizes; either 40 millimeters to 20 millimeters and 20 millimeters to 5 millimeters sizes, as specified. Other sizes or combinations of sizes may be used when specified.

(2) Fine Aggregate

Fine aggregate for concrete shall conform to the requirements of BS 882. Coral sand shall not be used.

907 CEMENT

907.01 Cement to be Used

Cement to be used shall be Ordinary Portland Cement manufactured by an approved firm and comply in all respects with the requirements of the BS 12, and when directed by the Engineer, Portland Blast Furnace Cement or Sulphate Resistant Cement shall be used which comply in all respects with the requirements of the BS 146 or BS 4027.

907.02 Test Certificates and Tests on Site

Test certificates from the manufacturer or supplier shall be submitted for each consignment and shall indicate the results of the tests for compressive strength, setting time, soundness and fineness carried out in accordance with the requirements of the relevant British Standard, but the Engineer may require further tests to be made after the cement is delivered to the site. If such certificates are not made available, samples shall be taken from different bags or containers of the consignment, suitably packed, and sent for testing in accordance with the relevant British Standard to an authorized laboratory, or where directed by the Engineer.

The Engineer may require further tests to be made if any cement is stored on the site for a longer period than three months.

The failure of any sample to satisfy the requirement of the relevant British Standard shall entitle the Engineer to reject the entire consignment from which it was taken.

907.03 Cement Received Through Importing Agents

Each consignment of cement received through importing agents shall be accompanied by a further certificate stating that no cement has been rebagged or the percentage of rebagging (which shall not exceed 10%) as the case may be. The contractor shall state the name of the local supplier or importing agent and the approval of the Engineer, in writing, shall be obtained before the order of any consignment.

908 OTHER MATERIALS FOR IN-SITU CONCRETE

908.01 Water

Water shall be clean and free from oil, acid, alkali, earthy, vegetable or anic matter, or other deleterious substances in suspension or solution which may have a harmful effect of the Works. Water used for concrete, mortar, shall comply with the requirements of BS 3148 and shall be tested if there is any doubt as to its suitability. If water is not available from a public supply the Engineer's approval shall be obtained regarding the source of supply and manner of its use. Contaminated water shall not be used.

908.02 Admixtures

Unless agreed by the Engineer, neither admixtures nor cements containing additives shall be used.

908.03 Material for Forms, Falsework and Centering

All timber used for forms, falsework and centering shall be sound wood, well seasoned and free from loose knots, shakes, large cracks, warping and other defects. Before use on the work, it shall be properly stacked

and protected from injury from any source. Any timber which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. Forms which are unsatisfactory in any respect shall not be used. All shuttering for all outside surfaces above final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish.

Irrespective of nature or position, all joints in sheeting shall be sufficiently tight to prevent leakage of liquids from concrete.

If the Contractor proposes to use steel shuttering, he shall submit to the Engineer, dimensioned drawings of all the component parts, and give details of the manner in which it is proposed to assemble or use them. Steel shuttering will only be permitted if it is sturdy in construction and if the manner of its use is approved by the Engineer.

Struts and props shall, where required by the Engineer, be fitted with double hardwood wedges or other approved devices so that the moulds may be adjusted as required and eased gradually when required. Wedges shall be spiked into position and any adjusting device locked before the concrete is cast.

908.04 Mould Oil

Mould oil shall be of an approved brand and shall be used in accordance with the Manufacturer's recommendation or as directed by the Engineer.

909 REINFORCING STEEL

Reinforcing steel shall comply with the requirements of BS 4449 or BS 4461. The Steel shall be free from oil, grease, dirt and paint and any loose rust shall be removed before use. No heating except for fish-trailing and no welds except in reinforcing fabric shall be made in any

bar without permission in writing from the Engineer. All bending shall be done by an approved machine and in accordance with BS 4466.

The Contractor shall supply the Engineer with a certificate stating the origin and process of manufacture and test sheets, signed by the maker, giving the results of each of the tests applied. If and when required he shall also grant all necessary facilities to the Engineer for the selection of test pieces and shall cause these to be prepared and submitted where directed for test. The Engineer shall have the option of testing and approving at the works of the suppliers all or any of the steel required under the Contract, and the Contractor shall advise the Engineer when the whole or any of the steel is ready for test at the Works, in order to conform with the provisions of the relevant British Standard as regards Test and Inspection.

910 MATERIALS FOR PRESTRESSED CONCRETE

910.01 Sheaths

All sheaths shall be either as described in the Contract or of form, gauge and dimensions appropriate to the prestressing system employed, subject to the approval of the Engineer.

910.02 Steel Tendons

Steel wire shall comply with the requirements of BS 2691.

High tensile alloy steel bars shall be made by the open hearth process (acid or basic) or by the electric process or by any of the oxygen prosecces, with the addition of the necessary alloying elements, and with sulphur and phosphorus contents each less than 0.05 per cent. When tested in accordance with BS 18, the steel shall have a tensile strength of at least 10,000 kg/cm^2 and a 0.2 per cent proof stress of not less than 80

per cent nor more than 90 per cent of the actual tensile strength.

Stress relieved 7-wire strand shall comply with the requirements of BS 3617 or have properties which are not inferior. The Contractor shall submit results of relaxation tests for the approval of the Engineer.

The Contractor shall supply in the form required by the Engineer manufacturer's certificates of tests on samples taken from each parcel of steel to be used.

Where directed by the Engineer, the Contractor shall arrange for samples of the steel intended for use in the Works to be tested at an authorized testing laboratory.

Wire and strand shall be supplied in coils of sufficient diameter to ensure that they lie out straight.

911 MATERIALS FOR CONCRETE BRIDGE

911.01 Bridge Bearings

The elastomer portion of the elastomeric compound shall be 100 per cent virgin natural polyisoprene (natural rubber) meeting the requirements shown on the Drawings or 100 per cent virgin chloroprene (neoprene) meeting the requirements shown on the Drawings.

911.02 Expansion Joints

(1) Expansion Joints for Bridge

Expansion joints shall be of the following types as shown on the Drawings:

Type A Transflex bridge expansion joint No.50 or similar
Type B Sho-bond cut off joint or similar

(2) Water-tight Joints for Box Culvert

Water-tight joints for box culvert shall be of the types shown on the Drawings, and subject to Approval by the Engineer.

911.03 Metal Parapets

The parapets shall comply with the requirements of Technical Memorandum (Bridges) No. BE5 Third Revision, November, 1973, issued by the Department of the Environment, United Kingdom.

911.04 Outlet Drains for Bridges and Other Drainage

All outlet drains shall be of corrosion resistant material PVC or other similar material to be approved by the Engineer and of the diameter and length as shown on the Drawings.

912 BITUMINOUS MATERIALS

Asphalt cements shall conform to the requirements of BS 3690.

As for penetration asphaltic cement 60/70 shall be used for hot-mix bituminous concrete.

913 ANCILLARY MATERIALS FOR ROAD WORKS

913.01 Turf

The turf used for verges and median strips shall be suitable for the climate and subject to the approval of the Engineer.

913.02 Grass Seed

Grass seed shall be a tested mixture from an approved source. The mixture shall be as approved by the Engineer.

913.03 Fertilizer

Fertilizer shall consist of an approved compound containing not less than:

10 per cent Nitrogen

15 per cent Phosphoric Acid

10 per cent Potash

or similar approved composition.

The Contractor may add any additional plant nutrients which he considers the constitution of the soil to warrant.

913.04 Guardrails

Guardrails shall be "Beam type Guardrails" shown on the Drawings or other equivalent approved by the Engineer.

913.05 Precast Concrete Products

Precast kerbs, slabs, and edging shall comply with the requirements of BS 340 and with the Drawings.

Where the Contractor is permitted to carry out precasting on site, the precast units shall in addition to complying with the relevant British

Standard be manufactured in steel moulds on a vibrating table and as directed by the Engineer.

The mortar for kerb sealing shall consist of one part portland cement and two parts approved sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

913.06 Paint for Road Marking

White road paint complying with BS 2086 made by an approved manufacturer shall be used.

914 MATERIALS FOR STORM DRAINAGE WORKS

914.01 Concrete Pipes

Concrete pipes shall comply with the requirements of BS 556 Reinforced Standard Pipe Proof Strength 2.010 kg/m. Where pipes are manufactured on site, all the clauses in these Specifications shall be applicable to the manufacture and testing of concrete pipes. Notwithstanding any of the requirements outlined above, for routine control purposes, the cube compressive strength should satisfy the requirements of grade 25 concrete as shown in Clause 402 of these Specifications.

914.02 Joint Materials

(1) Joint Fillers

Joint Fillers approved by the Engineer shall be used.

(2) Joint Mortar

Pipe joint mortar shall consist of one part portland cement and two parts approved sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

915 NATURAL STONE

915.01 Stone for Riprap

Stone for riprap to drains shall consist of sound undecomposed basalt with thickness not less than 10 centimeters obtained from approved boulders and be of even texture and colour.

915.02 Stone for Grouted Rubble Masonry

Stone for masonry walls shall consist of sound undecomposed basalt with the thickness required on the Drawings obtained from approved boulder and be of even texture and colour.

The amount of rubble stone to be used per square meter and the thickness shall be as follows:

Type C and Type E: 11 - 20 nr/m2, thickness more than 35 cm

Type P : 20 - 30 nr/m2, thickness more than 20 cm

915.03 Joint Mortar

The joint mortar for the riprap and grouted rubble stone masonry shall consist of one part portland cement and two parts approved sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

PART 10

TESTING

PART 10 TESTING

PART 10 TESTING

1001 SCOPE

The Contractor shall carry out necessary tests on the Site for selection, of materials design of mixes, control of materials and workmanship in accordance with the Technical Specifications and as instructed by the Engineer. The tests for selection of materials shall be carried out by the Field Testing Laboratory at the expenses of the Contractor. The tests for design of mixes, control of material and workmanship shall be carried out by the Engineer at the field testing laboratory under the supervision and direct control of the Engineer at the expenses of the Contractor.

Whenever the facilities of the Contractor's field testing laboratory are inadequate to carry out control tests on materials or workmanship, such tests shall be carried out at the Contractor's expense by a Testing Authority who shall be nominated by the Engineer, and the Contractor shall be fully responsible for any delays in the testing or work which may ensure.

1002 PROVISION AND OPERATION OF FIELD LABORATORY

1002.01 General

Permission to commence any major construction operations shall not be given by the Engineer until the Contractor has provided a field laboratory in full working order suitably equipped and staffed. The Contractor shall appoint and employ qualified laboratory technicians who shall work in the field testing laboratory for the period of the Contract

and adequate semi-skilled and unskilled labour to allow to carry out any and all of the tests by the methods described hereunder, and at the speed and in volume required by the progress of the works, and the Engineer's instructions. The Contractor shall ensure that at all times during the period of the Contract, he has sufficient quantity of apparatus, equipment, chemicals and other materials. The Contractor shall provide all labour, tools and equipment that may be required for the digging of trial pits and collection of samples in connection with all tests.

All tests to be performed shall be in accordance with Standard Specifications of the BS, AASHO and ASTM as specified in these Technical Specifications.

The Contractor shall provide and maintain all essential services including facility of any power source required, lighting, clean water and sinks with adequate drainage facilities. The Contractor shall provide such work benches, tables and chairs as required by the Engineer. The Contractor shall maintain the building in a clean and tidy condition and shall be responsible for the security of the building and its contents at all times.

1002.02 Field Laboratory

The laboratory shall be of similar construction to the office except that a steel floated concrete floor, without option, shall be provided. The laboratory shall have a minimum floor area of $80m^2$ divided into an office with a floor area of approximately $10m^2$ and a working area comprising the rest.

The working area floor shall have a strengthened section incorporated consisting of 3m x 3m x 45cm thick mass concrete plinth. A separate sample store of at least $10m^2$ floor area shall be provided.

The permanent fixtures in the laboratory shall include 2 number double draining board stainless sinks, piped drinkable water supply to each and

waste water outlets. Work benches, comprising a working surface and one full length and width shelf under, of seasoned timber 90cm wide and 90cm high and of a total length of approximately 9m shall be provided.
Soaking tanks as specified below for CBR specimens shall be provided at floor level, under the shelves, in the stores section of the laboratory.
Concrete cube curing tanks as specified below shall be provided outside but adjacent to the laboratory building. Both the CBR tanks and concrete cube curing tanks shall have draining pipes built in.
On completion of the Contract the laboratory as specified above shall revert to the Employer.

1002.03 Furniture and Equipment of Field Laboratory

The following items shall be provided to furnish and equip the Laboratory. The Contractor's attention in drawn to the fact that there is a limit to the type and quantity of laboratory equipment available in Mauritius. But with respect to the performance of tests such as Bitumen Biscosity, Marshall Stability, Flush Point, Concrete Compressive Strength, CBR (excluding moulds), the Contractor may use, on a rental charge basis, the equipment or facilities which are equipped at the testing laboratory of MOW office. The contractor shall ensure that that equipment be sufficient in quality and quantity for testing for the works in accordance with the requirements of the Contract and shall use them or part there of as much as possible. He should therefore take adequate measures to ensure that the laboratory will be fully equipped to carry out the necessary testing at the start of the work.

(1) Furniture

The Contractor shall be required to supply new the following listed furniture.

Desk with lockup drawers	1 nr

Desk chair	1 nr
Chairs	3 nr
Stationery cupboard 70 cu ft	1 nr
Book-case, made to accept box files, 2 shelves 1.8m long	1 nr
Stools, 90cm high	4 nr
Stools, 40cm high	2 nr
Metal Filing Cabinet 2 drawer	1 nr

(2) Equipment

The contractor shall be required to supply new equipment as listed, but not limitted to, here under.
In case the contractor proposes to use the whole or part of the equipment of the MOW Laboratory after inspection as aforestated, he shall at Tender list them instead of relevant equipment listed hereunder and make clear the details of rental charges or costs of any nature.

(a)	BS Compaction Test	
	BS Compaction mould complete with base plate and extension collar	2 nr
	4.5 kg compaction hammer, drop regulated to 458 mm	2 nr
	Straight edge 300 mm long with handles	2 nr
	Galvanised metal tray 1m x 0.5m x 75mm	2 nr
	75 mm brush	2 nr
	Balance, 7 kg capacity accurate to 1g and set of weights	1 nr
	20 nn BS Sieve, 300 mm diameter	1 nr
	Vibrating hammer with tamper to BS1377	1 nr
(b)	Density Test (Sand replacement method)	
	Sand pouring cylinder, 150 mm diameter	3 nr
	Sand pouring cylinder, 200 mm diameter	1 nr
	Round bottom vessel, 300 mm diameter with handles	4 nr
	Metal tray with 150 mm diameter hole in the centre 300 mm x 300 mm square	3 nr
	Metal tray 200 mm diameter hole in the centre 450 mm x 450 mm square	1 nr
	Steel pegs for fixing tray in position	12 nr

Cold Chisels 16 mm x 250 mm long	3 nr
Cold Chisels 10 mm x 250 mm long	3 nr
1 1/2 kg hammer	3 nr
Scoop for removing excavated material from hole, 250 mm long handle	3 nr
100 mm brush	3 nr
50 mm brush	3 nr
Camping Gas with burners	2 nr
Calibrating can 150 mm diameter x 150 mm deep	1 nr
Calibrating can 200 mm diameter x 150 mm deep	1 nr

(c) CBR Test

CBR Moulds, 180 mm high, complete with base plate and extension collar	2 nr
CBR Moulds, 180 mm high, complete with base plate and accepting extension collars provided above	45 nr
Perforated swell plates with an adjustable centre post of rust proof metal provided with a lock-nut	50 nr
2 1/2 kg, surcharge weights	94 nr

Particular Note

With respect to the following sort of equipment of CBR Tests, The Contractor may use the whole or part of equipment at the testing laboratory of MOW office on a rental base. The contractor shall ensure that the equipped facilities be sufficient in quality and quantity for testing for the works of contract and shall be requested to use them as much as practicable.

Displacer disc 50.8 mm thick	2 nr
Displacer disc 42.5 mm thick (thickness stamped on disc)	2 nr
Displacer disc 8.38 mm thick	2 nr

	Static compaction press, 25 tonnes capacity with an adjustable daylight between plattens from 530 mm to 250 mm (Hydraulic or mechanical operation)	1 nr
	CBR load frame (electric operation)	1 nr
	Proving ring for the above 2,000 kg capacity complete with deflection gauge	1 nr
	Proving ring as above but 3,000 kg capacity	1 nr
	Penetration gauge range 0 - 25 mm	2 nr
	CBR plunger	1 nr
	Swell measurement tripods matched to CBR moulds complete with gauges calibrated in 1/10 mm divisions	1 nr
	Hydraulic Jack 25 tonne capacity	2 nr
	CBR soaking tank 2.5 m x 0.7 m x 0.3 m	2 nr
(d)	Specific Gravity of Aggregates	
	A wire mesh basket (to BS 812)	1 nr
	Pycnormeters (to BS 812)	1 nr
	Balance of capacity not less than 3 kg accurate to 0.1 g and of such a type and size as to permit the basket containing the sample to be suspended from the beam and weighed in water	1 nr
(e)	Flakiness	
	Flakiness gauge in accordance with BS 812	1 nr
(f)	Bitumen Extraction to BS 598	

Particular Note

With respect to the following sort of equipment of Bitumen Extraction and Marshall Tests, the Contractor may use the whole or part of the equipment at the testing laboratory of the MOW office on a rental basis. The contractor shall ensure that the equipped facilities be sufficient in quality and quantity for testing for the works of contract and shall be requested to use them as much as practicable.

	A cylindrical container 150 mm diameter and 150 mm high with a metal pot, a graduated receiver and a reflux condenser all in accordance with BS 598 Hot Extraction Method, complete set	2 nr
	A pressure filter having an internal diameter of 270 mm. An air pump for supplying oil-free air at about 2 bar and a funnel for supporting sieves and for insertion into the filling orifice in the pressure filter, complete set	2 nr
	Electric hot plate with a thermostatic control suitable for heating the items above	2 nr
(g)	Marshall Test to ASTM 1559	
	Marshall moulds	3 nr
	Specimen extractor	1 nr
	Compaction hammer	2 nr
	Compaction pedestal	1 nr
	Specimen mould holder	1 nr
	Breaking head	1 nr
	Marshall load frame, electrically operated fitted with a suitable load measuring device of maximum capacity 2300 kg - accurate to 4.5 kg up to 450 kg and accurate to 11 kg between 450 kg and 2300 kg	1 nr
	Flowmeter	2 nr
	Water bath at least 275 mm depth of water thermostatically controlled to 60°C - 0.5°C The tank shall have a perforated false bottom to support the specimens 80 mm above the bottom of the bath	1 nr
	Armoured glass or dial type thermometers with metal stems 10°C to 210°C	4 nr
(h)	Miscellaneous Equipment	
	Paraffin Pressure Lamps	2 nr
	Fire Extinguishers	2 nr

1 m x 1 m x 75 mm deep galvanized metal trays	5 nr
1 1/2 kg hammers	1 nr
3 1/2 kg hammers	1 nr
7 kg hammer	1 nr
Cold Chisels 12 1/2 mm	3 nr
Oven, thermostatically controlled to 105°C - 110°C, 0.25 cu.m minimum capacity (electrical)	1 nr
Oven, thermostatically controlled to $\pm$1°C in range 80°C - 200°C with fan assisted air circulation	1 nr
Moisture content tins, 75 mm diameter, cadmium plated or aluminum	200 nr
Liquid limit device complete with two grooving tools (to B.S. 1377) and one cup each for clay and sandy material	1 nr
3m Straightedge	1 nr
Steel Rulers 300 mm graduated in mm	2 nr
Wheelbarrow (rubber tyred)	2 nr
Concrete cube moulds 150 mm x 150 mm x 150 mm	12 nr
Concrete cube curing tanks 2.5 m x 1.7 m x 0.3 m	2 nr
Slump cone	2 mr
Linear Shrinkage moulds	6 nr
Vernier calipers for Linear Shrinkage	1 nr
100 mm x 300 mm x 8 mm plate glass	2 nr
Steel rod 75 mm long x 3.2 mm diameter	1 nr
Pallete knives 200 mm blade x 32 mm wide	4 nr
Pallete knives 160 mm blade x 25 mm wide	4 nr

Electric or chaindial balance weighing to 150 gm accurate to 0.01 gm and set of weights	1 nr
Adjustable pliers	2 nr
200 mm x 200 mm x 20 mm cadmium plated or aluminium tins	12 nr
Balance 25 kg capacity accurate to 5 gm and set of weights	1 nr
Wash bottles	3 nr
Plastic measuring cylinders 1000 c.c.	2 nr
Plastic measuring cylinders 500 c.c.	2 nr
Plastic measuring cylinders 100 c.c.	2 nr
Facit calculator or equivalent (electric)	1 nr
Pentel Markers or equivalent	6 nr
Clip boards	3 nr
Bitumen trays (0.3 m x 0.3 m x 25 mm high)	6 nr
50 ml specific gravity bottle with ground glass stopper	2 nr
Perforated slotted trays min. 40 No. 50 mm x 50 mm compartments with fibre glass soaking trough with dust proof cover SSS test	4 nr
Riffle boxes 20 mm and 40 mm size (to B.S. 1377)	1 nr
Electrically operated mixer of 5 litre capacity with detachable mixing bowl and accurately controlled heating element capable of maintaining the bowl at the required temperature for mixing asphaltic concrete. A wire whisk of suitable strength. The mixer must be capable of combining 2 kg of aggregate, filler and binder speedily and thoroughly, without loss of fine fractions. The sides of the bowl must be completely scraped by the whisk.	1 nr

One copy of each of the following standard specification:

BS 12	1 nr
BS 63 pt. 2	1 nr
BS 556	1 nr
BS 812	1 nr
BS 882	1 nr
BS 1377	1 nr
BS 1438	1 nr
BS 1881	1 nr
BS 1924	1 nr
BS 3148	1 nr
1975 ASTM standards parts 14 and 15	1 nr
BS 598	1 nr
BS 594	1 nr
AASHO Part II Methods of sampling and testing for Highway Materials	1 nr

(i) Consumables

Paraffin wax	100 kg
Distilled Water	4,000 litres
Canvas sample bags	300 nr
Gunny sacks	300 nr
Plastic bags	
900 mm x 600 mm - 1000 gauge	600 nr
450 mm x 600 mm - 1000 gauge	900 nr
Filter paper 150 mm diameter boxes of 100 sheets (whatman No 5 or similar)	60 nr
Filter paper 100 mm diameter boxes of 100 sheets (whatman No 5 or similar)	60 nr

Filter paper 150 mm diameter boxes of 100 sheets (whatman No 1 or similar)	60 nr
Sodium sulphate crystals	200 kg
Trichloroethylene to BS 580 Types 1 and 2	400 litres

(j) Sieves

300 mm Dia

75 mm	1 nr
63 mm	1 nr
50 mm	1 nr
37.5 mm	1 nr
28.0 mm	1 nr
20.0 mm	1 nr
14.0 mm	1 nr
10.0 mm	1 nr
6.30 mm	1 nr
5.00 mm	1 nr
3.35 mm	1 nr
600 micron	1 nr
425 micron	1 nr
300 micron	1 nr
300 mm dia Lid	1 nr
300 mm Dia Receiver	1 nr

200 mm Dia

2.36 mm	1 nr
2.0 mm	1 nr
1.18 mm	1 nr
600 micron	1 nr

420 micron	1 nr
300 micron	1 nr
212 micron	1 nr
150 micron	1 nr
75 micron	6 nr
200 mm Dia Lid	1 nr
200 mm Dia Receiver	1 nr

1003 TEST RESULTS

All samples and records shall be preserved for as long as the Engineer may direct and they shall be kept and labelled in an orderly fashion to his satisfaction. The results of all tests shall be entered on standard forms, samples of which will be provided by the Engineer and two legible copies of each completed form shall be delivered to him with the minimum of delay. No material shall be incorporated in or rejected from the Works until the results of all relevant test have been approved.

1004 ADDITIONAL TESTS

In addition to the tests required under other sub-clauses hereof, the Engineer shall have power to order independent tests of all materials to be carried out by some person appointed by him at such place as he may determine and from the result of such tests there shall be no appeal.

1005 INSPECTION AND TESTING OF MANUFACTURED MATERIALS

Whenever considered desirable by the Engineer, Inspectors may be sent to the Manufacture to test the materials or to supervise their manufacture. Materials shall be tested before leaving the Manufacture as well as after delivery to the Site and the Engineer shall be at liberty to reject materials notwithstanding the preliminary test at the manufacture. Should the Engineer not decide to send an Inspector to the Manufacturer's Works, the Contractor shall obtain from the Manufacturer Certificate of Test, proof sheets, mill sheets, etc... showing that the materials have been tested in accordance with the requirements of these Specifications relating thereto and shall provide adequate means of identifying the materials on site with the corresponding certificates etc... but neither the omission of the Engineer to send an Inspector nor the production of the Manufacturer's Certificate of Test shall affect the liberty of the Engineer to order further tests on samples selected from the materials delivered to the site and to reject after delivery materials found to be unsuitable or not in accordance with these Technical Specifications.

1006 TESTS OF SUSPECT MATERIALS AND WORKMANSHIP

Where so directed, tests other than the tests specified herein, shall be carried out on the completed works or portions thereof at any time until the final hand over certificate has been issued. Where there is any doubt that the work has not been carried out in accordance with the provisions of the Contract or the Engineer's instructions, such tests shall be carried out jointly by the Engineer and the Contractor, or at the request of either party, by an independent Testing Authority who shall be nominated or approved by the Engineer.

1007 SAMPLING OF MATERIALS

1007.01 Description

Samples of materials to be tested shall be carried out in accordance with methods hereinafter described, or as referred to in the appropriate method of testing. In all other cases, the method shall be as directed by the Engineer.

1007.02 Trial Pits

Trial Pits, dug by hand, shall have a minimum plan area of 1 meter by 1 meter.
Samples shall not be taken from the spoil of the trial pit but shall be obtained from equal increments taken from each face of the pit, each increment being a representative sample of the material taken from any single horizon. The four increments so obtained shall be thoroughly mixed by turning over three times and then quartered or riffled down to the size required for testing.

1007.03 Stockpiles

The surface material of the stockpile shall be removed before sampling. At least twelve equal portions shall be taken from different parts of the stockpile, and thoroughly mixed by hand before being quartered down or riffled down to the size required for testing.

1008 TESTING OF NATURALLY OCCURRING MATERIALS

1008.01 Preparation of Disturbed Samples for Testing

The preparation of disturbed samples for testing shall be carried out in accordance with the procedure given in BS 1377.

1008.02 Tests on Naturally Occurring Materials

The tests shown below shall be conducted in accordance with the relevant British Standard or

Moisture Content	:	BS 1377 Test 1A or subject to the Engineer's approval by calcium carbide bomb to makers instructions with calibration against BS1377 Test 1A
Speedy Moisture Content	:	as directed by the Engineer
Liquid Limit	:	BS 1377 Test 2A
Plastic Limit	:	BS 1377 Test 3
Plasticity Index	:	BS 1377 Test 4
Specific Gravity	:	BS 812
Bulk Density	:	BS 812
Particle size distribution	:	BS 1377, Tests 7A and 7B
Sand Equivalent	:	AASHO T 176

All sievings shall be done by the wet method. Dry sieving may only be carried out with the specific permission of the Engineer.

1008.03 Compaction Tests

The tests shall be carried out in accordance with BS 1377 test 12.

1008.04 California Bearing Ratio Test

The test shall be carried out in accordance with BS 1377 test 1
cynamic compaction method 1.
All CBR Specimen shall be prepared at BS Heavy Optimum Moisture Content and at BS Heavy Optimum Moisture Content +2%.
All CBR tests on unstabilised soils are to be carried out after 4 days soaking.

1009 TESTING OF AGGREGATES

1009.01 Sampling of Aggregates

The sampling of aggregates shall be carried out in accordance with the procedure given in BS 812 Section 1.

1009.02 Tests on Aggregates

Sieve Analysis	:	BS 812 Section 3 Clause 11
Amount passing No. 200		
B.S. Sieve	:	BS 812 Section 3 (Method B) Clause 13
Flakiness Index Test	:	BS 812 Section 3 Clause 15
Specific Gravity	:	BS 812 Section 4 Clause 18 to 21
Bulk Density	:	BS 812 Section 4 Clause 24 to 25

Los Angeles Abrasion Test	:	AASHO Designation T 96-49
Sand Equivalent Test	:	AASHO T 176
Moisture Content	:	BS 812 Section 5 Method A
Speedy Moisture Content	:	as directed by the Engineer

1010 TESTS FOR WATER PURITY

The tests for water purity shall be conducted in accordance with the relevant British Standard 3148.

1011 TESTS FOR MANUFACTURED MATERIALS

1011.01 Ordinary and Rapid Hardening Portland Cement

Test		British Standard
Compressive Strength Test	:	BS 12 Clause 6 Method 1 or 2
Consistency of Standard Cement Paste	:	BS 12 Clause 7
Initial and Final Setting Times	:	BS 12 Clause 8
Soundness Test	:	BS 12 Clause 9
Fineness Test	:	BS 12 Clause 4

1011.02 Bituminous Materials

Sampling Bituminous Materials	:	AASHO T 40
Penetration Test	:	AASHO T 49
Softening point	:	AASHO T 53
Ductility Test	:	AASHO T 51
Viscosity	:	AASHO T 201/T 59
Solubility Test	:	AASHO T 44
Distillation	:	AASHO T 78
Residue from distillation	:	AASHO T 59
Flash Point	:	AASHO T 48/T 79

1011.03 Tests on Reinforcing Steel Bars and Wires

Tensile and cold bend tests shall be carried out in accordance with BS 449, 4482, 4461, 4483, 2691, 4360 according to the kind of steel bars and wires.

1011.04 Tests on Rubber Bearing for Bridges

Rubber bearings shall be subjected to tests as required in the Contract or approved by the Engineer.

1012 TESTS FOR CONTROL OF MATERIALS AND WORKMANSHIP

1012.01 Field Moisture Content Test

This test shall be carried out in accordance with BS 1377, Part 2,

Test 1 or by using a Speedy Moisture Tester as directed by the Engineer. When using the latter method it must be noted that the instrument requires calibration for each type of material being tested. To improve the accuracy of the instrument, at least six small ball bearings should be placed in the Speedy Tester and these will assist in breaking up the soil, so allowing the calcium carbide to react with the moisture more readily.

1012.02 In-Situ Dry Density Control Test

The test shall be carried out using the sand-cone method, the rubber-balloon method as directed by the Engineer in accordance with British Standard.

1012.03 Measure of Deflection under 8 tons Axle Load

This test shall be carried out as directed by the Engineer.

1012.04 Bituminous Concrete

Sampling of bituminous mixture	:	AASHO T 41
Bulk Density	:	As directed by the Engineer
Bitumen Content	:	AASHO T 58
Marshall	:	ASTM D 1559

The samples for Marshall tests shall be compacted with 50 blows on each face.

1012.05 Concrete

Sampling	:	BS 1881
Slump Test	:	BS 1881
Compressive Strength Test	:	BS 1881
Indirect Tensile Strength	:	BS 1881

(a) Tests for Structural Concrete

Where a batch has been sampled for the purpose of making cube tests,

1 cube shall be made from each of the 3 samples for test at 28 days. The cubes shall be made, cured and tested in accordance with BS1881. They shall be tested in a laboratory approved by the Engineer who shall receive certified copies of the results of all tests.

The appropriate strength requirements for each set of 3 cubes shall be satisfied if none of the strengths of the 3 cubes is below the cube strength specified in Tables 47 or 48 or if the average strength is not less than the specified cube strength and the difference between the greatest and least strengths is not more than 20 per cent of the average.

Where a batch has been sampled for the purpose of determining the workability of the concrete, 1 test shall be made on each sample by compacting factor apparatus or "V-B" consistometer in accordance with BS 1881, or other method approved by the Engineer. For a designed mix, the workability of the concrete shall correspond to that of the accepted trial mix within the following limits:

Compacting factor $\pm$ 0.03

"V-B" consistometer $\pm$ 3 seconds or $\pm$ 15 percent of the average time whichever is the greater.

For standard mixes the tolerances shall be as described in Table 48.

(b) Testing of Pretensioned Beams

Any beam selected by the Engineer shall be subjected to a loading test. The Contractor shall not proceed with a loading test until he has obtained the approval of the Engineer to the detailed arrangements.

The beam shall be supported at its design points of bearing. The specified test loads shall be applied equally at the third points of the span in not less than 10 approximately equal stages. The maximum load shall be sustained for 5 minutes and then removed in not less than 5 approximately equal stages. The midspan deflection relative to a straight reference line joining the points of support shall be measured for each value of the load and 5 minutes after removed of the load.

Loads shall be measured with an accuracy of $\pm$ 2 per cent or 0.05 ton and deflections with an accuracy of 1 milimeter.

The load-deflection graph shall be plotted from these values and shall shown no appreciable variation from a straight line, the deflection shall not exceed the specified maximum deflection and the recovery shall be not less than 90 per cent of the maximum deflection.

The Contractor shall supply to the Engineer record sheets showing the age of the beam at the time of the test, loads deflections, load-deflection curves and calculated value of Young's Modulus of Elasticity.

1013 FREQUENCY OF QUALITY CONTROL TESTING IN SITE

The frequency of testing for earthwork, concrete, crushed stone subbase course, bituminous treated base course, bituminous concrete surface

course and reinforcing steel bar shall be as indicated on tables from 1001 to 1005.

1014 FREQUENCY OF TESTINGS FOR OTHER MANUFACTURED MATERIALS

The frequency of testings for all other manufactured materials shall be as indicated in the relevant British Standards or as directed by the Engineer.

Table 10-1 TESTS FOR EARTHWORK

Material	MATERIAL TESTS		QUALITY CONTROL TESTS	
	Method of Test	Frequency	Method of Test	Frequency
Embankment	Sieve Analysis Moisture Content Specific Gravity Atterberg Limits Compaction Test CBR Test	1/50,000 M^3	Moisture Content Field Density	1/2,000 M^3 or at least 1/day of supply
Road-bed including selected backfill material	Sieve Analysis Moisture Content Specific Gravity Atterberg Limits Compaction Test CBR Test	1/10,000 M^3	Moisture Content Field Density	1/1,000 M^3 or at least 1/day of supply

Table 10-2 TESTS FOR CONCRETE

MATERIAL TESTS (Testing for each class of concrete shall be required)		QUALITY CONTROL TESTS	
Method of Test	Frequency	Method of Test	Frequency
Aggregates Sieve Analysis Specific Gravity Bulk Density Washing Analysis Los Angeles Abrasion Test Flakiness Test	As directed by the Engineer	Sieve Analysis Surface water Content	1/day of supply
Water	Ditto		
Cement Certificate by the Manufacturer	Ditto	Not required	Not required
Admixture Certificate by the Manufacturer	Ditto		
Trial Mix Slump Air Content Compressive strength	Ditto		
Concrete	Ditto	Slump Air Content	As directed by the Engineer
		Compressive Strength	1/50 M^3 or at least 1/day of placing

Table 10-3 TESTS FOR GRADED STONE SUBBASE COURSE

MATERIAL TESTS		QUALITY CONTROL TESTS	
Method of Test	Frequency	Method of Test	Frequency
Sieve Analysis Los Angeles Abrasion Test Flakiness Index Test CBR Test	For selection of material, when source of supply is changed during the works when required by the Engineer	Sieve Analysis Field Density	1/2,000 M^3 or at least 1/day of supply

Table 10-4 TESTS FOR BITUMINOUS TREATED BASECOURSE AND BITUMINOUS CONCRETE SURFACE COURSE

Aggregates Sieve Analysis Specific Gravity Los Angeles Abrasion Test Flakiness Index Test CBR Test	For selection of material, when source of supply is changed during the works when required by the Engineer		
Bitumen Certificate by the Manufacturer			
Bituminous Mixture Job Mix Formula	For determining Mix Ratio before commencing works	Plant: Sieve Analysis Density Asphalt Content	2/day of mixing
		Core: Thickness Compaction	1/day of paving

Table 10-5 TESTS FOR REINFORCING STEEL BAR

MATERIAL TEST	
Method of Test	Frequency
Certificate by the Manufacturer	
Tensile strength	As directed by the Engineer

1015 ALTERATION IN FREQUENCY OF TESTS

Notwithstanding any provision in these Technical Specifications as to the frequency of tests, the Engineer shall be empowered to alter the number, type or nature of such tests, as may in his opinion be necessary for the proper execution of the Works. The Engineer shall be at liberty to increase the frequency of testing, repeat tests which in his opinion is unsatisfactory and vary the nature and type of test.

1016 CONTROL OF SURFACES

The Contractor shall provide straight edges (3 m), templates for checking the finish of the surfaces. They shall be maintained in good condition during all the works.

1017 MEASUREMENT AND PAYMENT

1017.01 Testing

No measurement and payment shall be made for tests, but any costs incurred in carrying out the tests on materials and quality control, including cost for sampling and transport of samples shall be deemed to have been included in the contract unit prices for the relevant parts of the Works.

1017.02 Field Laboratory

This Item shall be included in the Pay Item A02.12 of Bill "A" of the Bill of Quantities, all of which will revert to the Employer on Completion of the Contract.

Payment of the Lump Sum tendered for the Pay Item A02.12 of Bill "A" will be made on the following basis:

(a) 25 % when construction of the building is substantially complete.

(b) 75 % when the laboratory is fully staffed and equipped and functioning to the satisfaction of the Engineer.

Payment for operating and maintenance of the Laboratory will be at the discretion of the Engineer but no payment will commence before the laboratory is no payment will commence before the laboratory is substantially complete both as regards construction and supply of equipment and testing has commenced.