SERIES 4000: EARTHWORKS

TABLE OF CONTENT

LIST OF TABLES AND FIGURES 5

DIVISION 4100: PREPARATION OF ROAD BED AND PROTECTION OF EARTHWORKS 6

4101 General 6
(a) Scope 6
(b) Dimensions 6
4102 Construction Requirements for the Preparation of Road Bed and Sub-Grade 6
(a) Equipment 6
(b) Shaping and Compaction of the Roadbed on Suitable Material 6
4103 Treatment of The Existing Ground and of the Road Bed Materials in Cut 6
(a) Removal of Unsuitable Material 6
(b) Three-pass roller compaction 7
(c) Preparation and compaction of existing ground in fill sections and of roadbed material in cut sections 8
(d) Draining of Existing Ground and Road Bed 8
(e) In Situ Treatment of Roadbed 8
(f) Widening the roadbed 9
4104 Protection of Earthworks 9
(a) Scope 9
(b) Construction Requirements for Protection of Earthworks 9
4105 Measurement and Payment 10
Item 41.01 Removal of unsuitable material (including free-haul of 1.5 km) 10
Item 41.02 Three roller passes compaction 10
Item 41.03 Roadbed preparation and the compaction of material 10
Item 41.04 In situ treatment of roadbed 11
Item 41.05 Material bladed to windrow 11
Item 41.06 Extra over items 41.02, 41.03 and 41.04 for preparing and /or treating the roadbed and compacting material in restricted areas 11

DIVISION 4200: ROADWAY AND BORROW EXCAVATION 12

4201 General 12
(a) Scope 12
(b) Dimensions 12
4202 Topsoil 12
4203 Borrow 12
4204 Classes of Excavation 12
(a) Common (Normal) Excavation 12
(b) Intermediate Excavation 13
(c) Rock (Hard) Excavation 13

(d) Boulder Excavation 13
4205 Unsuitable Material Excavation 13
4206 Method Of Classifying 14
4207 Construction Requirements for The Excavation of Cuttings 14
(a) Equipment 14
(b) Excavation General 14
(c) Dimension of Cuttings 15
(d) Use of Excavated Material 15
(e) Disposal of Surplus Excavated Soil or Rock 16
4208 Measurement And Payment 16
General directions 16
Item 42.01 Cut and Borrow to Fill including free- haul up to 1.5 km 17
Item 42.02 Extra over item 42.01 for excavating and breaking down material 18
Item 42.03 Cut to spoil, including free-haul up to 1.5 km 18
Item 42.04 Over break in rock(hard) and boulder class A excavation 19
Item 42.05 Widening of cuts (extra over items 42.01, and 42.03) 19

DIVISION 4300: BORROW MATERIALS 21

4301 Scope 21
4302 Obtaining Of Borrow Materials 21
(a) Borrow Pit Locations 21
(b) Use of borrow materials. 21
4303 Opening And Working of Borrow Pits 21
(a) Removal of topsoil 21
(b) Clearing and grubbing 22
(c) Excess overburden 22
(d) Excavation of Borrow Material 22
(e) Control at Borrow Pits 23
(f) Protection of Borrow Pits 23
4304 Reinstatement of Borrow Areas 23
4305 Disposal of Borrow Material 23
4306 Classification of Borrow Pits for Gravel Materials for Pavement Layers 24
4307 Measurement and Payment 24
Item 43.01 Excess overburden 24
Item 43.02 Excess over burden in borrow pits for obtaining crushed stone for pavement layers 24
Item 43.03 Finishing - off borrow areas 25

DIVISION 4400: EMBANKMENT CONSTRUCTION 26

4401 General 26
(a) Scope 26
(b) Sources of Materials 26
4402 Material Requirements For Construction of Embankments in Suitable Material 26
(a) Californian Bearing Ratio (CBR) 26
(b) Liquid Limit and Plasticity Index 26
(c) Maximum Particle Size 26
4403 Material Requirements For Construction Of Embankments In Rock Fill 26
4404 Material For Side Fill 27

4405 Construction Requirements For Embankments 27
(a) Equipment 27
(b) General 27
(c) Spreading of Materials 28
(d) Oversize Particles 28
(e) Compaction 28
(f) Benching 28
(g) Constructing a pioneer layer 28
(h) Construction of Drainage Blankets 29
(i) Construction of high fills 29
(j) Sand fill and sand filter blankets 29
(k) Construction of fills near structures 30
(l) Constructing toes for rook fill embankments 30
(m) Side Fill Material 30
(n) Trial Areas 30
4406 Measurement And Payment 30
Item 44.01 widening of fills 31
Item 44.02 Extra over item 42.03 for spoiling material excavated from benches constructed for widening existing fills 31
Item 44.03 Extra over sub item 42.01(c) for correcting rock fills that are deficient in fine material 31
Item 44.04 Sand fills 31

DIVISION 4500 : FINISHING OF SLOPES 33

4501 General 33
(a) Scope 33
(b) Dimensions 33
4502 Construction Requirements For Finishing Of Slopes 33
(a) Equipment 33
(b) General 33
4503 Cutting Slopes 33
4504 Embankment Slopes 33
4505 Measurement And Payment 34

DIVISION 4600 : STABILIZATION 35

4601 Scope 35
4602 Materials 35
(a) Material to be stabilized 35
(b) Chemical stabilizing agents 35
4603 Chemical Stabilization 36
(a) Preparation of Layer 36
(b) Application of Stabilizing Agent 36
(c) Mixing in of stabilizing agent 37
(d) Watering 37
(e) Compaction 37
(f) Finishing at Junctions 38
(g) Curing of Stabilized Work 38
(h) Construction Limitations 39

4604 Mechanical Modification 39
(a) Modifying soil and gravel by the addition of a soil binder 39
(b) Mixing materials from various sources 40
(c) Recombining recovered material 40
4605 Bituminous Stabilization 40
(a) Preparing the material 40
(b) Mixing in the additive 40
(c) Heating and diluting the bituminous stabilizing agent 40
(d) Applying the stabilizing agent 41
(e) Compaction 41
(f) Finishing at Junctions 42
(g) Construction limitations 42
4606 Construction Tolerances 42
(a) Rate of Application 42
(b) Uniformity of mix 42
4607 Construction of Trial Section 42
4608 Stabilization Work In Restricted Areas 43
(a) General requirements 43
(b) Chemical stabilization 43
(c) Bituminous stabilization 43
4609 Quality Control 44
(a) Process Control 44
(b) Routine Inspection and Testing 44
(c) Defective Work or Materials 44
4610 Measurement And Payment 45
Item 46.01 Chemical stabilization 45
Item 46.02 Chemical stabilizing agent 45
Item 46.03 Mechanical modification (extra over untreated layer) 45
Item 46.04 Provision and application of water for curing 46
Item 46.05 Curing by covering with the subsequent layer 46
Item 46.06 Bituminous stabilization 46
Item 46.07 Bituminous stabilizing agent 46
Item 46.08 Additive for bituminous stabilization 47
Item 46.09 Extra over item 46.01 for chemical stabilization in restricted areas 47
Item 46.10 Extra over item 46.03 for mechanical modification in restricted areas 47
Item 46.11 Extra over item 46.06 for bituminous stabilization in restricted areas 47
Item 46.12 Extra over items 46.01 and 46.06 for trial sections 47

LIST OF TABLES AND FIGURES

Table 4400 /1 Grading Requirements for Rock Fill 27
Table 4600/1 Maximum time for completion in stabilization 39

DIVISION 4100: PREPARATION OF ROAD BED AND PROTECTION OF EARTHWORKS

4101 GENERAL

(a) Scope

This Division covers all work in connection with the preparation of the road bed, prior to the construction of the embankments or capping layers, and the preparation of the sub-grade prior to the construction of the pavement layers.

(b) Dimensions

The dimensions shall be in accordance with the cross sections and details shown in the Contract or as instructed by the Engineer.

4102 CONSTRUCTION REQUIREMENTS FOR THE PREPARATION OF ROAD BED AND SUB-GRADE

(a) Equipment

Equipment used for the preparation of the roadbed and sub-grade shall be suitable for use on the surface to be prepared.

(b) Shaping and Compaction of the Roadbed on Suitable Material

The existing ground beneath embankments or the bottoms of cuttings classified as suitable material which has a density of less then 95% of the maximum dry density determined in accordance with AASHTO T-180, shall be scarified to a minimum depth of 150mm, watered and re-compacted in accordance with the requirements of Clause 4405.

4103 TREATMENT OF THE EXISTING GROUND AND OF THE ROAD BED MATERIALS IN CUT

After areas of the existing ground that are to be covered by fill have been cleared and grubbed, or after excavation in cut has reached the top of road bed, the Contractor shall treat the existing ground in fill sections, or the roadbed materials in cut sections as specified hereunder.

(a) Removal of Unsuitable Material

Any material, occurring below the existing ground surface in fill areas or roadbed material in cut areas, which is considered by the Engineer to be of a quality that would be detrimental to the performance of the completed road, shall be removed to such widths and depths as ordered by the Engineer and disposed of as directed. The excavated spaces shall then be backfilled with approved imported material compacted to the required density.

The Engineer may also order that unsuitable material which is too wet to provide a stable platform for the construction of the fill be removed and replaced with suitable dry material,

and the Contractor shall be paid for this work provided the Engineer is satisfied that, despite adequate temporary drainage installed by the Contractor and permanent drainage that the Contractor may have installed, the wet conditions are not likely to be remedied within a reasonable time and could not have been reasonably foreseen and avoided by proper advance planning for construction during a dry period.

The removal of unsuitable material shall be paid for under item 41.01. For payment, a distinction shall first be made in respect of the stability of the material and the construction equipment to be used. Any unstable material will be paid for under item 41.01. For removing stable material, payment will be made under item 41.01 should the instruction to remove be given after completion of the excavations in accordance with the original instructions. If not, payment will be made therefore under Division 4200 as for ordinary excavated material that is taken to spoil.

For the purpose of this clause and of payment item 41.01 stable material shall be defined as material which can be removed effectively by means of normal road-construction equipment such as bulldozers, graders, scrapers, mechanical shovels, back hoes or excavators. Unstable material shall be material which can be removed effectively only by means of dragline scrapers or similar equipment.

(b) Three-pass roller compaction

Where the existing ground in fill sections, or the roadbed in cut sections, by reason of its inadequate in situ density is specified or prescribed by the Engineer to be given three roller passes compaction, it shall be prepared by shaping if necessary and compacting with a heavy pneumatic tired, vibratory flat steel drum, pad foot (tamping) or grid roller complying with the requirements specified or with an impact roller. The pneumatic roller shall consist of pneumatic tired wheels mounted on a rigid frame with loading platform or body suitable for ballast loading to produce a load of between 25 kN and 80 kN on each wheel and arranged in a manner that will allow all wheels to bear equally while operating on uneven surfaces.

The total load on any axle line shall not exceed 300 kN. Tires shall be uniformly inflated under operating conditions to a pressure within the range 500 kPa to 800 kPa. The roller shall be ballasted in accordance with the requirements of the Engineer.

The vibratory flat steel drum and pad foot roller shall be capable of exerting a combined static and dynamic load of not less than 120 kN/m at an operating frequency not exceeding 1500 rpm.

The grid roller shall have a mass of not less than 13 tons when ballasted, and shall be loaded to this mass.

The impact roller shall be a multi-aced roller having a maximum of five flat or nearly flat faces and a roller mass of between 5 and 10 tons. The roller and towing mechanism, which shall be of the free fall type, shall be so designed that all the energy applied in lifting the roller when the roller is supported on the ridge between consecutive faces, will be available for dissipation on impact when the roller drops down again. The roller shall be towed at a speed of between 8 km and 12 km per hour.

Unless authorized by the Engineer, compaction shall comprise not less than three complete coverage’s by the wheels of the roller specified or ordered over every portion of the area being compacted. While it is not the intention that water be applied to the road bed by the Contractor under this class of compaction and while no rigid control of moisture will be exercised during compaction, the Contractor shall nevertheless satisfy the Engineer that every

endeavor is being made to take full advantage of more favorable soil moisture conditions during the year and to carry out such compaction as far as possible, when the road bed is neither excessively dry nor excessively wet.

The Engineer shall be fully authorized to decide as to when conditions are favorable for compaction and where such compaction shall be done at any particular time. He is authorized to instruct the Contractor to water the existing ground or roadbed at the Contractor's expense where, in the opinion of the Engineer, the Contractor has failed to comply with these requirements. Where required, three roller passes compaction shall be followed up by the process described in c) below.

(c) Preparation and compaction of existing ground in fill sections and of roadbed material in cut sections

Any part of the existing ground in fill sections or roadbed material in cut sections classified as suitable for use in place except that it fails to meet the requirements for density, shall be scarified, watered and compacted to a percentage of AASHTO T 180 maximum dry density. The type of compaction and the depth of compaction shall be as directed by the Engineer. If necessary, the material may have to be temporarily bladed off to windrow in order to achieve the necessary depth of compaction.

Where any additional material has to be imported to obtain the required levels and layer thickness, and where the thickness of the imported material, measured after compaction, would be less than the specified layer thickness, then the material shall be scarified, the necessary imported material placed, and this combined material mixed and compacted to the full specified depth of the layer. The imported material shall be measured and paid for under "Cut and borrow to fill" and the original existing material shall be measured and paid for under "Preparation and compaction of existing ground in fill sections and of roadbed material in cut sections".

(d) Draining of Existing Ground and Road Bed

Any drainable waterlogged existing ground and road bed, such as saturated material overlying less pervious strata shall first be drained by the installation of all permanent surface or subsoil drainage shown on the Drawings or as directed by the Engineer, before any other construction is started on these sections.

Such drains shall be constructed, measured and paid for in accordance with the requirements of Division 3100.

(e) In Situ Treatment of Roadbed

Wherever shown on the Drawings or directed by the Engineer, the roadbed in cuts shall be treated in situ by breaking up undesirable formations of hard or rocky materials in order to achieve a uniform standard of compaction or to improve drainage.

Treatment in situ shall consist of ripping or blasting the roadbed to depths, which, on normally cambered sections, shall increase from the center of the roadbed to the edges. Unless otherwise indicated on the Drawings or directed by the Engineer, the depth of ripping in the center of the roadbed shall not be less than 300 mm and at the edges of the roadbed not less than 500 mm. Similarly the depth of drilling and blasting shall not be less than 700 mm at the center of the roadbed, and shall slope outwards to not less than 1000 mm at the edges of the roadbed. On super elevated sections the treatment shall, if so directed by the Engineer or

shown on the Drawings, have a uniform cross fall and a minimum depth of 400 mm in the case of ripping and 850 mm in the case of blasting.

After ripping or blasting the material shall be processed as follows:

Where the Engineer instructs the Contractor to rip the in situ material, the whole of the material shall be sized by rolling or breaking until the maximum dimension of any clod or spall is not more than two-thirds of the thickness of the layer after compaction. The material shall then be compacted as described in this Sub-clause.

Where the Engineer instructs the Contractor to blast the in situ material, the whole of the material shall be processed and compacted as described in this clause or as directed by the Engineer.

In both cases surplus material arising from bulking after treatment in place shall be removed and disposed of or utilized elsewhere as directed by the Engineer.

(f) widening the roadbed

Where the road is to be widened, and where so instructed by the engineer, the roadbed shall be treated in accordance with the provisions of clause 4103. Where uncompacted roadbed material occurs below the outer part of the fills, the fill material shall be cut back or cut away to expose the full width of the roadbed widening to be treated.

Such widening shall be constructed, measured and paid for in accordance with the requirements of Series4000.

4104 PROTECTION OF EARTHWORKS

(a) Scope

This section covers all work in connection with the protection of earthworks (including, excavations, embankments, slopes, road bed and sub-grade) from the effects of weather.

(b) Construction Requirements for Protection of Earthworks

Earthworks shall be protected from the weather at all times. The compacted layers of fill and the bottom of excavations shall be adequately drained and shaped to prevent free water standing on or scouring the completed layer or the in-situ material. Any windrows or ridges, which will impede the free drainage of water, shall be removed from the surface. No fill material for a succeeding layer has been shall be placed if the underlying layer has been softened by excessive moisture.

All permanent drains, plus additional necessary temporary drains, shall be constructed as soon as possible to protect the earthworks. Ruts, potholes and other damaged sections of earthworks and slopes shall be reinstated. Drains shall be so constructed as to avoid damage, caused by erosion, to embankments.

Any runnels or erosion channels, which develop during the Contract, shall be back filled with suitable material, and the areas reinstated. The Contractor shall not allow erosion to develop on a large scale before effecting repairs and all erosion damage shall be repaired as soon as possible.

4105 MEASUREMENT AND PAYMENT

Item 41.01 Removal of unsuitable material (including free-haul of 1.5 km):

(a) In layer thicknesses of 200 mm and less:

(i) Stable material ..... cubic metre (m^3)

(ii) Unstable material .....cubic metre (m^3)

(b) In layer thicknesses exceeding 200 mm:

(i) Stable material .....cubic metre (m^3)

(ii) Unstable material.....cubic metre (m^3)

The unit of measurement shall be the cubic metre of unsuitable material removed by the contractor in accordance with the engineer's instructions and it shall be the in situ volume of the material calculated in accordance with its authorized dimensions.

For the purposes of this clause the definitions of stable and unstable material shall be as set out in clause 4103(A).

The tendered rates shall include full compensation for the removal of all classes of unsuitable material and shall distinguish only between stable and unstable material and layer thicknesses of less than and exceeding 200 mm. It will also include compensation for free-haul of 1.5 km.

Item 41.02 Three roller passes compaction:

Vibratory roller ..... square meter (m^2)

Oscillatory roller ..... square meter (m^2)

Grid roller..... square meter (m^2)

Tamping roller..... square meter (m^2)

Impact roller..... square meter (m^2)

Pneumatic-tyred roller ..... square meter (m^2)

The unit of measurement shall be the square meter of roadbed compacted in accordance with the provisions of clause 4103(b). The quantity will be computed in accordance with the authorized dimensions of the area to be treated.

The tendered rates shall include full compensation for shaping, providing the rollers, keeping the rollers ready for use when soil-moisture conditions are favorable as specified, and compacting the roadbed by three roller passes.

Item 41.03 Roadbed preparation and the compaction of material:

(a) Compaction to 90% of modified AASHTO density .....cubic meter (m^3)

(b) Compaction to 93% of modified AASHTO density .....cubic meter (m^3)

The unit of measurement shall be the cubic meter of roadbed material prepared and compacted as specified in clause 4103(c). The quantity shall be computed in accordance with the authorized dimensions of the completed layers.

The tendered rates shall include full compensation for shaping, scarifying, mixing of in situ and imported material if required, and preparing and compacting the material's as specified.

Item 41.04 In situ treatment of roadbed:

(a) In situ treatment by ripping ..... cubic meter (m^3)

(b) In situ treatment by blasting ..... cubic meter (m^3)

The unit of measurement shall be the cubic meter of in situ material treated in situ as specified in clause 4103(e). The quantity shall be computed in accordance with the authorized dimensions of the completed in situ treatment.

The tendered rates shall include full compensation for ripping or blasting, shaping, scarifying, sizing, knapping, rolling, mixing of in situ and imported material if required, and preparing and compacting the material as specified. Payment shall distinguish between in situ treatment by ripping and in situ treatment by blasting. Surplus material shall be measured and paid for as in Division 4200.

Item 41.05 Material bladed to windrow .....cubic meter (m^3)

The unit of measurement in respect of material temporarily bladed to windrow as specified in clause 4103(c) shall be the cubic meter of material to be bladed off, measured in the original position before balding off in accordance with the method of average end areas.

The tendered rate shall include full compensation for the temporary removal of such material and its later replacement, and for all clearing work, which may be necessary after replacement of the material.

Only material bladed to windrow on the instructions of the engineer for exposing the underlying roadbed material for treatment will be measured and paid for as described above.

Item 41.06 Extra over items 41.02, 41.03 and 41.04 for preparing and /or treating the roadbed and compacting material in restricted areas

(a) Item 41.02 for three roller passes compaction ..... square metre (m^2)

(b) Item 41.03 for roadbed preparation and the compaction of material .. cubic meter (m^3)

(c) Item 41.04 for in situ treatment of roadbed..... cubic meter (m^3)

The unit of measurement shall be the cubic meter or square meter of prepared and/or treated roadbed or compacted material, depending on the type of work required, as indicated for the various items where such work is required to be done in restricted areas. The quantities shall be calculated as specified under items 41.02, 41.03 or 41.04 whichever may be the case.

The tendered rate shall include full compensation for the additional cost of executing the work in restricted areas.

No distinction in payment will be made between the various density requirements, the various types of rollers, and between ripping and blasting.

DIVISION 4200: ROADWAY AND BORROW EXCAVATION

4201 GENERAL

(a) Scope

This Division covers all work in connection with the excavation of soil and rock within the road prism and borrow areas except for excavation for foundations.

(b) Dimensions

The dimensions of cuttings and other excavations shall be in accordance with the cross sections and details as described in the Contract and further amended during the course of construction by instructions from the Engineer.

4202 TOPSOIL

After clearing and grubbing of the natural ground surface within the width of the road prism, the Contractor shall obtain from the Engineer an instruction as to whether topsoil is to be removed and as to the required treatment of any topsoil on the section concerned.

This shall indicate the depth to which the topsoil is to be removed, whether it is for re-use or spoil, and the location of stockpiles, spoil areas or placement. The depth of removal of topsoil will be either zero or an average depth between 150 mm and 400 mm.

Topsoil shall be stockpiled in heaps not more than 3 meters high.

This work shall be measured and paid for under Division 4100.

4203 BORROW

Where sufficient quantities of suitable material are not available from roadway excavation as planned, additional materials shall be excavated from borrow pits indicated on the plans or approved by the Engineer.

4204 CLASSES OF EXCAVATION

(a) Common (Normal) Excavation

Common excavation shall be excavation in material, which can be efficiently removed or loaded by any of the following equipment without prior ripping:

A bulldozer with a mass of at least 22 tons and an engine developing approximately 145 kW at the flywheel; or

A tractor-scraper unit with a mass of at least 28 tons and an engine developing approximately 245 kW at the flywheel, pushed during loading by a bulldozer as specified above, or

A track-type front-end loader with a mass of at least 22 tons and an engine developing approximately 140 kW at the flywheel.

(b) Intermediate Excavation

Intermediate excavation shall be excavation in material, which can be efficiently ripped by a bulldozer with a mass of at least 35 tons when fitted with a single tine ripper and an engine developing approximately 220 kW at the flywheel.

(c) Rock (Hard) Excavation

Rock excavation shall be excavation (excluding boulder excavation) in material which cannot be efficiently ripped by a bulldozer fitted with a ripper with properties equivalent to those described in (ii) above.

(d) Boulder Excavation

Boulder excavation shall be classified in the following three classes:

(i) Class A Boulder

Boulder excavation class A shall be excavation in material containing in excess of 40% by volume of boulders between 0.03 m^3 and 20 m^3 in size. In a matrix of common material or smaller boulders.

(ii) Class B Boulder

Boulder excavation class A shall be excavation in material containing of 40% or less by volume of boulders between 0.03 m^3 and 20 m^3 in size. In a matrix of common material or smaller boulders.

(iii) Class C Boulder

Isolated individual boulders within a cutting of common or intermediate excavation and not less than 1 m^3 in volume, which can be bodily removed by the contractor's equipment, without prior blasting shall be classified as class C boulders.

4205 UNSUITABLE MATERIAL EXCAVATION

Unsuitable Material Excavation shall consist of the excavation and disposal of trash, rubble, wood, debris, non- regulated industrial wastes and other miscellaneous materials including soil or rock cover and intermingled soil or rock materials, which is unsuitable.

Materials unsuitable for use in the Works shall include:

Peat, materials from swaps, marshes and bogs that contain excessive amounts of black cotton soil, logs, tree stumps and other perishable materials;

Soil having a liquid limit exceeding 60% or a plasticity index exceeding 30 when determined in accordance with the requirements of AASHTO T-89 and T-90 which are sufficiently wet and soft to prevent them being trafficked or excavated by normal bulk earthmoving equipment.

Regulated Industrial Wastes - Regulated industrial wastes excavation shall consist of the excavation and disposal of these materials classified as regulated industrial wastes in the Special Provision.

Wet Excavation - Wet excavation shall consist of the excavation of muck, mud, unstable materials and all other materials and objects of whatever nature encountered that cannot be excavated by ordinary dry excavation methods and equipment.

Removal of Concrete Base and Surface Courses - Removal of Concrete base and surface courses shall consist of the excavation of reinforced and non -reinforced concrete courses including any overlying surface courses.

Removal of Bituminous Concrete Overlay - Removal of bituminous concrete overlay shall consist of the Removal of bituminous concrete, block and brick surfaces from reinforced and non-reinforced concrete bases.

4206 METHOD OF CLASSIFYING

The Contractor shall be at liberty to use any method he wishes to excavate any class of material but the method of excavation shall not determine the classification of the excavation.

The Engineer shall determine the classification of the excavation. In the first instance the classification shall be based on an inspection and evaluation of the material to be excavated. This classification shall be determined before excavation commences. In the event of a disagreement between the Contractor and the Engineer, the Contractor shall, if required, make available such mechanical equipment at his own cost, in order to determine whether or not to the material can reasonably be removed. The decision of the Engineer as to the classification shall thereafter be final and binding.

The Contractor shall immediately inform the Engineer if and when the nature of the material being excavated changes to the extent that a new classification for further excavation is warranted. Failure on the part of the Contractor to timely advise the Engineer shall entitle the Engineer to classify in his sole discretion, such excavation as may have been executed in material of a different nature.

4207 CONSTRUCTION REQUIREMENTS FOR THE EXCAVATION OF CUTTINGS

(a) Equipment

Equipment used for the excavation of cuttings shall be suitable for the type of material to be excavated.

(b) Excavation General

The Contractor shall exercise proper care when excavating material not to loosen, where this can be avoided, any material outside the specified cutting line, whether by ripping, blasting or other means, thereby endangering the stability of the slopes or subsequently causing undue erosion or disintegration of the batters. his would normally entail modifying the methods of excavating when working in the vicinity of the final cutting surface.

Care shall also be exercised not to undercut any slopes and proper control shall at all times be exercised by regular survey checking and the use of batter boards at close intervals. Where the batters are nevertheless undercut, back filling and compacting with imported material will not normally be considered as a suitable remedy and the Engineer may order such remedial measures, as he considers necessary to be carried out at the Contractor’s expense. This may, in serious cases, include cutting back the whole or major portions of the batter to a uniform slope.

Construction equipment shall not use the surface of the bottom of a cutting unless the cutting is in rock containing no soft material or the Contractor maintains the level of the bottom surface at least 300 mm above finished subgrade level. The Contractor shall reinstate any damage to the subgrade or roadbed level arising from such uses of the surface. From the time the Contractor begins to trim the remaining material to subgrade or roadbed level on any given area, the movement and use of construction equipment thereon, other than that used to complete this operation, shall be kept to a minimum.

(c) Dimension of Cuttings

The dimensions of cuttings shall be in accordance with the cross sections and details as shown on the Drawings and further amended during the course of construction by instructions from the Engineer.

All cuttings excavated below the specified levels shall be back-filled with suitable material and compacted to the satisfaction of the Engineer. The Contractor should anticipate that a certain amount of over-break might be inevitable in hard excavation or in the presence of boulders.

During excavation the Contractor shall limit vertical and other temporary faces to such heights as are suitable to the nature of the exposed soil. If in the course of the Works any slips, slides or subsidence extend below the line and slopes or below the levels shown on the Drawings, the excess excavation shall be carried out at the Contractor's own expense. The Contractor shall reinstate the slopes in a manner satisfactory to the Engineer. Unless he can show that the slip, slide or subsidence was not due to his failure to comply with the Specifications. The Engineer may, when he considers it necessary, instruct the Contractor to widen cuts already existing, completed or partially completed either uniformly or by altering the slope of the sides of cut, or by cutting benches, or in any other way.

(d) Use of Excavated Material

All materials excavated from the road prism shall, insofar as is practicable, be used for the construction of embankments, pavement layers and for such other purposes as shown on the Drawings or as directed by the Engineer.

The Contractor shall not dispose of any excavated material without the approval of the Engineer. Excavated material, which is unsuitable for use in any part of the Works, or surplus to requirements, shall be disposed of at points approved by the Engineer and in a manner satisfactory to him. Spoil heaps shall be neatly trimmed and finished to even surfaces.

Coarse rock encountered in cuts shall be utilized for the construction of the lower layers of fills high enough to accommodate thick layers, or, where so required, shall be conserved and used as directed for constructing the sides of embankments or for serving as protection against embankment or channel erosion.

The Engineer shall have full control of the use of all material from excavations of cuttings, but the Contractor shall plan his operations and particularly his cut-to-fill operations in such a manner that all cut material may be used to the best advantage of the Employer. No material shall be unnecessarily spoiled or borrowed. The Contractor shall neither borrow nor spoil any material without the Engineer's approval and without satisfying the Engineer that this is necessary and the most economical method of constructing the Works.

Generally the works shall progress in an orderly fashion with suitable material being cut to adjacent fills. In general the excavated materials shall be placed directly in their final position in fill.

Hauling of material from cuts to embankments or other areas of fill shall only take place when sufficient compaction equipment is operating at the place of deposition to ensure compliance with the relevant clauses of this Division.

The Contractor shall utilize only equipment, which is suited to the soils to be handled. He shall not at any time use any equipment, which damages or reduces the natural strength more than necessary of the soil either in its in-situ state or during handling and placing or in its final compacted state.

Where directed by the Engineer prior to commencement of work, the Contractor shall submit a statement of his proposed plan of operation and if so directed the Contractor shall not commence the work until the Engineer approves such plan. The plan shall be additional to any construction program required under the Contract.

(e) Disposal of Surplus Excavated Soil or Rock

The Contractor shall not dispose of any excavated soil or rock without the prior approval of the Engineer.

Excavated soil or rock which is either unsuitable for use in the works or is surplus to requirements, shall be disposed of in specially designated areas, identified by the Contractor and approved by the Engineer. If necessary, the area shall be cleared and grubbed in accordance with the requirements of Division 2100 prior to the surplus soil or rock being tipped and spread in layers and compacted to the approval of the Engineer. After compaction the surface and slopes of the finished disposal area shall be trimmed to the satisfaction of the Engineer.

4208 MEASUREMENT AND PAYMENT

General directions

(i) Determining the quantities

Upon completion of all work in connection with clearing and grubbing and working the roadbed, and where the classification of the excavations change, the contractor, at his own cost, shall take cross-sections at 20 m intervals so as to determine quantities, and shall submit the results so obtained to the engineer for approval. The engineer will take control measurements to determine the accuracy and adequacy of the cross-sections, and may instruct the contractor to correct any faulty work and to take such additional measurements and cross-sections as may be deemed necessary by him. Such cross-sections shall be taken before any cut or fill work is done. Where the contractor proceeds with such work before final approval of the cross-sections and before the contractor and the engineer have agreed on the cross-sections, the engineer's decision regarding the cross-sections to be used shall be final and binding on the contractor.

Where there is valid reasons for believing that the roadbed is subsiding as fills are being constructed, and after the roadbed work has been completed and cross-sections have been agreed on, the contractor may request that the fill quantities shall be adjusted accordingly. Such request shall be lodged without delay, and the contractor shall submit the required

supporting evidence to the engineer. Where the engineer is satisfied that significant subsidence is occurring, he, together with the contractor, shall decide as to how the extent of the subsidence is to be determined, and, where no agreement can be reached, the decision of the engineer shall be final. Any adjustments of this nature shall be made only where the average subsidence exceeds 50 mm.

(ii) Material from commercial sources

If specified in the project specifications, material from commercial sources shall be used for the construction of fills. In such cases the items listed below shall be applicable, except that the tendered rates shall also include full compensation for all transport costs, and no overhaul shall be measured and paid for.

(iii) Work in restricted areas

Special rates for works in restricted areas are applicable solely to work that has to be executed in an area of which the width is less than 3.0 m or the length is less than 150.0 m.

Item 42.01 Cut and Borrow to Fill including free- haul up to 1.5 km:

(a) Material in compacted layer thicknesses of 200 mm and less:

(i) Compacted to 90% of modified AASHTO density..... cubic metre (m^3)

(ii) Compacted to 93% of modified AASHTO density..... cubic metre (m^3)

(b) Material in compacted layer thicknesses exceeding 200 mm:

(i) Compacted to 90% of modified AASHTO density..... cubic metre (m^3)

(ii) Compacted to 93% of modified AASHTO density..... cubic metre (m^3)

(c) Rock fill (as specified in subclause 4403)..... cubic metre (m^3)

(d) Toes for rock fill embankments (as specified in subclause 4405(l)) .... cubic metre (m^3)

(e) Pioneer layer (as specified in subclause 4405(g))..... cubic metre (m^3)

(f) Sand filter blanket (as specified in subclause 3307(h))..... cubic metre (m^3)

The unit of measurement shall be the cubic metre of material measured in the compacted fill. For sub - items (a), (b) and (c) the quantity measured shall be computed by the method of average end areas from levelled cross-sections prepared from the ground line after clearing and grubbing and the removal of topsoil and the completion of any preparatory roadbed treatment which may have been ordered by the engineer, but prior to the construction of the fill, and the final specified or authorized fill cross-section superimposed thereon at 20 m intervals along the center line of the road. All measurement shall be neat, and that part of the fill placed in excess of the authorized cross-section shown on the drawings or directed by the engineer, will not be paid for irrespective of the tolerances in workmanship allowed under the contract. Where the roadbed has subsided under the fills, the quantities shall be adjusted to make allowance for such subsidence, as set out in the note at the commencement of this clause. Measurement of fill shall distinguish between the alternative methods of processing and compacting.

The quantities for subitems (d) and (f) shall be calculated from the authorized dimensions.

For subitem (e) the compacted volume of the material in the pioneer layer may be taken as equal to 70% of the loose volume of the material in the trucks as an alternative to taking cross-sections before and after construction.

Material excavated for the construction of open drains, subsoil drains, culverts, bridge foundations and other structures, shall, if suitable and if so directed by the engineer, be used for the construction of fills, and payment shall be made under item 42.01 irrespective of any payment made previously for the excavation of such material. All such material shall be classified as Common (Normal) excavation.

The tendered rates shall include full compensation for procuring, furnishing and placing the material, including excavating as if in Common (Normal) excavation, the cutting of benches, for transporting the material for a free-haul distance of 1.5 km; for preparing, processing, shaping, watering, mixing, and compacting the materials to the densities or in the manner specified herein and for removing and disposing of up to 5% oversize material from the road after processing, including transport for a free-haul distance of 2.5 km.

The tendered rates shall also include full compensation for the supply and installation of synthetic-fiber filter material where specified or indicated on the drawings.

Payment shall distinguish between the various materials and methods of processing and compacting specified, as itemized above.

Item 42.02 Extra over item 42.01 for excavating and breaking down material in:

(a) Common (Normal) excavation ..... cubic meter (m^3)

(b) Intermediate excavation.....cubic meter (m^3)

(c) Rock (Hard) excavation.....cubic meter (m^3)

(d) Boulder excavation class A ..... cubic meter (m^3)

(e) Boulder excavation class B.....cubic meter (m^3)

(f) Boulder excavation class C.....cubic meter (m^3)

The unit of measurement shall be the cubic meter of material removed as specified.

Measurement of items (a), (b), (c) and (d) shall be in the original position in the cut or borrow pit and the quantity shall be computed by the method of average end areas from levelled cross-sections at intervals not exceeding 20 m measured along the center line of the road in the case of cuts and at intervals not exceeding 10 m and parallel to one another in the case of borrow pits before and after the removal of the material Measurement of boulder excavations in class B and class C shall be by the volume of individual boulders being measured after removal or where this is considered to be impracticable by taking the in situ volume of boulder excavation to be equivalent to 50% of the loose volume in the hauling vehicles

The tendered rates shall be paid as extra over the rates applying to Common (Normal) excavation in item 42.01 and shall include full compensation for additional costs to excavate and break down the various classes of material including the cost of all the necessary additional effort plant tools materials, labour and supervision.

The extra over payment shall distinguish between common (normal), intermediate, rock (hard), boulder class A, boulder class B and boulder class C excavation.

Item 42.03 Cut to spoil, including free-haul up to 1.5 km Material obtained from:

(a) Common (normal) excavation .....cubic meter (m^3)

(b) Intermediate excavation ..... cubic meter (m^3)

(c) Rock (Hard) excavation..... cubic meter(m^3)

(d) Boulder excavation class A ..... cubic meter (m^3)

(e) Boulder excavation class B ..... cubic meter (m^3)

(f) Boulder excavation class C ..... cubic meter(m^3)

The unit of measurement shall be the cubic meter of material measured in its original position in cut and computed by the method of average end areas from levelled cross-sections taken along the ground line after clearing and grubbing and the removal of topsoil, if any, but prior to excavating the cut with the final specified or authorized cross-section of the cut superimposed thereon at intervals not exceeding 20 m along the center line of the road.

Measurement of boulder excavation class B and class C shall be by the volume of individual boulders being measured after removal or where this is considered to be impracticable by taking the in situ volume of boulder excavation to be equivalent to 50% of the loose volume in the hauling vehicles.

Where measurement by cross-sections is considered by the engineer to be impracticable cut to spoil may be measured in the hauling vehicles by taking the in situ volume of the material in the case of soils and gravel to be the equivalent of 70% of the loose volume in the haul vehicles and in the case of boulder material as equal to 50% of the loose volume in the haul vehicles.

The tendered rates for cut to spoil shall include full compensation for excavating from the road prism and roadbed in the various classes of excavation, for loading, transporting the material for a free-haul distance of 1.5 km, off-loading and disposing of the material as specified, including shaping and levelling-off any piles of spoil material

This payment item will also apply to the removal of unsuitable roadbed material provided that it is stable material and that instruction in respect of its removal be given before the excavations reach the level of the roadbed material to be removed, all as described in Division 4100.

Except where the temporary storage of spoil material is ordered by the engineer, the tendered rates shall also include full compensation for the temporary storage of spoil material, the later loading, transporting, off-loading and grading of the spoil material within the borrow areas, and for reinstating the storage site to its original condition.

Item 42.04 Over break in rock(hard) and boulder class A excavation .square meter (m^2)

The unit of measurement shall be the square meter of exposed roadbed in completed rock (hard) and boulder class A cuttings.

The tendered rate for over break in rock (hard) and boulder class A cuttings shall include full compensation for unavoidable over break which may occur during excavation and for the cost of backfilling with suitable rack material and compacting it to the lines and levels specified for the excavation. This item shall not apply when item 41.04 of Division 4100 is applied in respect of the same area.

Item 42.05 Widening of cuts (extra over items 42.01, and 42.03):

(a) In rock (hard) material..... cubic meter (m^3)

(b) In boulder material class A ,B or class C .....cubic meter (m^3)

(c) In all other materials .....cubic meter(m^3)

The unit of measurement shall be the cubic meter of material excavated during the widening of cuts where they are more than 2. 5 m deep (measured vertically from the top of the cut to the shoulder breakpoint), and where the cut is widened by less than 4 m.

Measurement of the material shall be in the original position in the cut and the quantity shall be computed by the method of average end areas from levelled cross-sections at intervals not exceeding 20 m measured along the centerline of the road before and after removal of the material.

The tendered rates for widening the cuts shall be paid extra over the rates tendered for items 42.01, and 42.03 and shall include full compensation for the additional costs involved (over and above those for excavating new cuttings) for excavating material during the widening of a cut where the cut exceeds 2.5 m in depth and is widened by less than 4 m.

DIVISION 4300: BORROW MATERIALS

4301 SCOPE

This Division covers the work involved in obtaining materials for construction of the Works from borrow areas. It includes clearing the site, stripping overburden including topsoil, excavating selected material for use in the Works, and reinstatement of the borrow area.

4302 OBTAINING OF BORROW MATERIALS

(a) Borrow Pit Locations

Borrow material shall be located and obtained by the Contractor. Borrow material shall comply with the requirements of the Specifications for the use for which the material is intended.

The Contractor shall excavate the necessary trial holes, take such samples and perform or have performed such tests as are necessary. The Contractor shall submit all the results to the Engineer in sufficient detail to satisfy him that the quality and quantity of material available in the proposed borrow area is acceptable for the intended use, all at the Contractor's own expense.

Approval of borrow pits or borrow areas shall apply only to those portions of the pit or area from which acceptable materials can be obtained or produced. The Contractor shall conduct his operations in any approved pit or borrow area or portions thereof so as to produce acceptable material.

Any approval given by the Engineer shall not relieve the Contractor of the responsibility of ensuring that material obtained from a borrow pit complies in all respects with the specification for the material.

Procuring and furnishing borrow material shall not be payable directly but shall be considered as a subsidiary obligation of the Contractor covered under the contract prices paid for the various items of work in which the materials are used, as provided in these Specifications. Certain items of work shall, however, be paid for separately where so specified.

(b) Use of borrow materials.

The Engineer shall not approve the use of any material from borrow areas unless the Contractor has made full use of all available materials within the Site.

4303 OPENING AND WORKING OF BORROW PITS

(a) Removal of topsoil

Prior to the opening of a borrow pit the Contractor shall ascertain from the Engineer whether the removal of topsoil is required and shall remove and stockpile such topsoil as instructed by the Engineer.

This work shall be carried out, measured, and paid for, in accordance with the provisions of Division 4100.

(b) Clearing and grubbing

Clearing and grubbing of borrow areas will be measured for payment in accordance with the provisions of Division 2100 of these Specifications before excavation is commenced, but only in the following cases unless otherwise directed by the Engineer:

(i) in borrow areas located in plantations.

(ii) in borrow areas where no excess overburden exists but the removal of grass, shrubs, and roots is required.

No clearing and grubbing will be measured or paid for in borrow areas opened for obtaining rock or sand used in the construction of stone pitching, concrete work, crushed stone base or subbase, permeable subsurface drain material or bituminous asphalt or surfacing.

(c) Excess overburden

The Contractor shall advise the Engineer in good time of his intention to operate from any borrow area before any excavation at such borrow area is commenced, in order that a survey of site can be made for the purpose of computing the quantity of excess overburden, if any, to be removed.

No removal of overburden of other quarrying operations shall be proceeded with until agreement has been reached between the Engineer and the Contractor in regard to the quantity of such overburden.

The measurement of excess overburden shall be made only after removal of topsoil and clearing and grubbing, if any, has been performed.

Excess overburden shall be moved, as instructed by the Engineer, to the outer limits of the proposed borrow area and if this area is later increased the excess overburden shall be moved further to the new outer limits or where possible at that stage, replaced in the borrow pits as described in clause 4304.

(d) Excavation of Borrow Material

Where any borrow pit contains different types of materials in separate layers which require to be mixed in order to produce a suitable product, the materials shall be excavated over the full depth of approved face in one operation without separation of the different types of material.

The Contractor shall exercise all reasonable care so as to avoid contamination of approved borrow material by the inclusion of clayey or otherwise unsuitable material from the floor of the borrow pit, from overburden, from unsuitable layers or from areas beyond the approved limits of the borrow area. During loading hard oversize material which will not break down during processing on the road shall be excluded as far as is practicable, including if necessary the use of a grizzly. During the course of borrow operations and especially when excavating near the floor and outer boundaries of borrow areas the Contractor shall plan his operations so as to reduce as far as possible the amount of earthmoving that will be necessary for the finishing-off of borrow pits. Indiscriminate excavation without due regard for the desired final shape of the borrow pit will not be permitted.

The material in borrow pits shall be blasted, ripped or excavated in a manner that will ensure the effective breaking down of the material. Any oversize particles in material which is to be used for sub-bases, road bases or gravel wearing courses shall be removed by screening or other approved means before it is taken from the borrow pit.

(e) Control at Borrow Pits

The Contractor shall be responsible for controlling his operations at every borrow pit where material is being excavated, to ensure compliance with the requirements of clause 4303 above.

He shall carry out sufficient tests on the material being excavated from the borrow pit in order to satisfy himself that the quality of the material will comply with the specified requirements for the particular layer for which it will be used.

If there is any doubt concerning the quality of borrow material being excavated at any time, the Contractor shall notify the Engineer immediately, and in any case before such material is brought onto the road. The results of all tests, which are carried out by the Contractor, shall be submitted to the engineer on request. The Engineer will, after further testing or inspection if necessary, instruct the Contractor regarding the use of the material in the borrow area, or he may order the borrow pit to be finished off and abandoned.

(f) Protection of Borrow Pits

Borrow pits shall be continuously protected against the ingress of surface water and the Contractor shall construct such temporary banks as may be required to divert surface water and as far as possible his operations shall be planned in such a way that the borrow pit is self-draining. Where this is not possible, borrow pits shall be dewatered by pumping. The Contractor shall be solely responsible for keeping borrow areas dry and ensuring that borrow material is sufficiently dry when required for use.

4304 REINSTATEMENT OF BORROW AREAS

On completion of his operations in a borrow area the Contractor shall reinstate the entire area so as to blend with the surrounding area and to permit the re-establishment of vegetation. For this purpose the borrow area shall be shaped to even contours. All material in and around the borrow area, whether spoil from road building operations, excess stockpiled material, oversize material left in the borrow pit, material resulting from clearing and grubbing operations and excess overburden, shall be used or disposed of as directed by the Engineer. Material not capable of supporting vegetation shall be buried and used in shaping the borrow area and subsequently covered with soft material. All available soft material shall be spread evenly to the thickness directed and where sufficient material is not available for this purpose to cover the entire area, the remaining portions shall be scarified along the contours so as to avoid undue erosion.

The shaping and reinstatement of the borrow pit shall be done in such a way that the borrow pit will be properly drained whenever practicable and where required the Contractor shall place earth banks to divert any surface water away from the borrow area.

The reinstatement of any borrow pit shall be to the entire satisfaction of the Engineer.

4305 DISPOSAL OF BORROW MATERIAL

The Contractor shall not have the right to use material obtained from borrow pits for any purpose other than for the execution of this Contract. He shall not dispose of any borrow material whether processed or not either by sale or donation to any person without the written authority of the Employer.

4306 CLASSIFICATION OF BORROW PITS FOR GRAVEL MATERIALS FOR PAVEMENT LAYERS

Borrow pits for the exploitation of gravel materials shall be classified in accordance with the same classification as that described in clause 4204 for construction of the earthworks. Borrow pits for exploiting stone for pitching or crushing, and borrow pits for sand shall not be classified for purposes of payment.

The engineer shall have the right to decide which borrow pit shall be operated by the contractor at any particular stage of the work and to approve new borrow pits during the construction period.

4307 MEASUREMENT AND PAYMENT

Item 43.01 Excess overburden ..... cubic meter (m^3)

The unit of measurement shall be the cubic meter of excess overburden measured in place before stripping and such measurement shall be based on the depth of overburden measured in trial pits excavated by the Contractor in a square pattern at intervals of 10 m over the whole area concerned.

Where the borrow material consists of rock or sand which is used in the construction of stone pitching, concrete work, crushed stone for sub-base and base, permeable subsurface drain materials and in bituminous paving and surfacing, no excess overburden shall be measured or paid for.

The tendered rate shall include full compensation for the digging of trial pits; stripping clearing and grubbing, and removing the excess overburden prior to the excavation of borrow material; for replacing the excess overburden in the borrow pit after completion of the excavation of borrow material and for levelling-off the excess overburden in the borrow area.

Item 43.02 Excess over burden in borrow pits for obtaining crushed stone for pavement layers

(a) Overburden in common (normal) or intermediate excavation.....cubic metre(m^3)

(b) Overburden in rock (hard) excavation .....cubic metre (m^3)

The unit of measurement shall be the cubic metre of excess overburden measured in place before stripping. The quantity shall be based on the depth of the overburden as measured in test pits. Distinction shall be made between common (normal) and intermediate material on the one hand and rock (hard) material on the other, in accordance with the classification as described in Sub- clause 4204 under Division 4200 for excavations.

The tendered rates shall include full compensation for stripping, removing and stockpiling excess overburden prior to the borrow material being excavated, replacing the excess overburden in the borrow pit after excavation of the borrow material has been completed and levelling-off the excess overburden in the borrow area.

Where the stockpiled excess overburden has to be moved to beyond the limits originally indicated by the engineer, it shall be measured once more for payment but only under item 43.01.

Where overburden material is used for filling or for other purposes, payment will not be made for removing such overburden material, but will be made in accordance with the purpose for which such material will be used.

Item 43.03 Finishing - off borrow areas

(a) Rock (Hard) material. ..... hectare (ha)

(b) Intermediate material ..... .hectare (ha)

(c) Common (Normal) ..... material. hectare (ha)

The unit of measurement for finishing-off borrow areas shall be the hectare measured in accordance with the finally excavated area of the borrow pit before it is finished off.

The tendered rates shall include full compensation for finishing-off the borrow pits as specified, including any further earth moving necessary for finishing, but excluding the establishment of grass. Borrow pits shall be classified in accordance with the classification of the material removed therefrom and where more than one class of material is taken from a borrow area, the area shall be apportioned prorata for classification purposes, in accordance with the volumes of each type of material removed.

DIVISION 4400: EMBANKMENT CONSTRUCTION

4401 GENERAL

(a) Scope

This Division covers all work in connection with the construction of embankments within the road prism up to the sub-grade level, using soil or rock excavated from the road prism or from approved borrow areas in accordance with these specifications and in conformity with the lines, grades, cross section, and dimensions shown on the plans or as instructed by the Engineer.

(b) Sources of Materials

Material used for the construction of embankments shall be obtained from cuttings, trenches or foundations within the limit of the Works or from borrow areas identified by the Contractor and approved by the Engineer.

4402 MATERIAL REQUIREMENTS FOR CONSTRUCTION OF EMBANKMENTS IN SUITABLE MATERIAL

(a) Californian Bearing Ratio (CBR)

The fill material shall have a minimum soaked Californian Bearing Ratio (CBR) of not less than 4% and a swell value of not more than 1.5% (with two surcharge rings) when determined in accordance with AASHTO T-193.

The Californian Bearing Ratio (CBR) shall be determined at a density of 95% of the maximum dry density determined in accordance with the requirements of AASHTO T-180 method D

(b) Liquid Limit and Plasticity Index

The fill material shall have a liquid limit not exceeding 60% and a plasticity index not exceeding 30 when determined in accordance with the requirements of AASHTO T-89 and T-90.

(c) Maximum Particle Size

The fill material shall not contain particles with a maximum dimension exceeding two-thirds of the specified layer thickness after compaction, except in the case of rock fill.

4403 MATERIAL REQUIREMENTS FOR CONSTRUCTION OF EMBANKMENTS IN ROCK FILL

Rock fill shall be material obtained from rock or intermediate excavation and shall comply with the following requirements:

Rock fill processing and compaction shall apply to material consisting predominantly of stone and boulders, with some fine material in between, which, on account of the mechanical

interlock of the rock, cannot be effectively compacted by construction methods normally used for soils and gravel.

When the layer thickness after compaction is 500 mm or less as instructed by the engineer, the processing and compaction of such material shall not be classified as rock-fill processing and compaction, and the engineer may prescribe that the material be compacted as described in clause (b)hard material.

The maximum size of rock, which may be used in rock fill, is 750 mm. and the layer thickness before compaction shall not be in excess of one and a half times the average actual size of the rock. The engineer may prescribe that 5% of the oversize material shall be bladed off the road after the material has been dumped onto the road, and it shall be disposed of as described in clause 3210, so that the layer thickness will not be determined by the presence of isolated large rock fragments.

The compacted layer shall not contain any rock fragments the largest dimension of which exceeds the thickness of the compacted layer.

The material to be compacted shall be off-loaded by the end-tipping method. The material shall then be spread by bulldozer or other suitable plant and shall be so bulldozed and levelled as to properly mix the fine material with the rock.

The rock fill shall contain sufficient finer fractions to fill the voids in order to obtain the maximum density. If the rock fill material is deficient in fines, approved fines shall be added to the rock fill and placed as specified in Sub-clause 4405. The addition of approved fines will be paid for separately as specified in item 44.03.

Table 4400 /1 Grading Requirements for Rock Fill

Sieve Size	Percentage Passing
500mm	100
125mm	0 - 90
600 μm	0 - 25
63 μm	< 15

4404 MATERIAL FOR SIDE FILL

Material for use in side fill shall be either material which is unsuitable for use in the construction of embankments, material which is surplus to requirements, or any material from borrow areas.

4405 CONSTRUCTION REQUIREMENTS FOR EMBANKMENTS

(a) Equipment

Fill material shall be compacted by the use of purpose made compaction equipment, which shall apply uniform compaction effort across the full width of the machine. Each type of fill material shall be compacted by equipment, which is suitable for the purpose.

(b) General

Fill, other than rock fill, shall be deposited in layers not exceeding 200mm compacted thickness. Each layer shall extend over the full width of the embankment.

Fill material shall be placed in successive layers approximately parallel to the final road surface. The construction of tapered layers shall be restricted to the bottom layers of embankments where this may be unavoidable due to cross-fall, tapering out of fills or super elevation of the final road surface.

(c) Spreading of Materials

Fill material shall be deposited on the compacted underlying surface, and evenly spread over the whole of the designated area for the layer concerned in such quantity that the thickness of any one layer, when measured after compaction, shall comply with the specified requirement.

Any new layer of less than 100mm in compacted thickness shall be mixed in to the previous layer by scarifying to such a depth that the total compacted thickness of the new layer plus the scarified portion of the previous layer will not be less than 100mm.

Rock fill shall be deposited and spread in horizontal layers not exceeding 750mm loose depth and shall extend over the full width of the embankment except for specified external cover to slopes. Each layer shall be blinded with granular material before the next layer is placed. Rock fill shall not be used for the top 400mm of the embankment.

(d) Oversize Particles

Any oversize particles which are not broken down to comply with the requirements of Clause 4402(c), prior to compaction, shall be removed from the layer and disposed of in accordance with the requirements of Clause 4207(e).

(e) Compaction

The moisture content of fill material, other than rock fill, at the time of compaction shall be the optimum for the equipment being used and not more than 2% above the optimum for the material determined in accordance with the requirements of AASHTO T-180. Each layer of fill shall be compacted to the following requirements:

1) For fill material other than rock fill: - not less than 95% of the maximum dry density determined in accordance with the requirements of AASHTO T-180;
2) For rock fill; Each layer of rock used as fill in embankment shall be systematically compacted by at least 8 passes of a vibrating roller with a static load of at least 36 kN per 1 metre width of roll or a grid roller with a static load of at least 80 kN per 1 metre width of roll or other equipment approved on site trials.

(f) Benching

Where the slope of the existing ground, in any direction, is greater than 20%, the existing ground shall be excavated to form horizontal benches which shall be a minimum of 1 metre wide or otherwise as described in the Contract. Each bench shall be excavated as the fill material is compacted and the embankment is raised. This requirement shall also apply to embankments constructed on rock.

Suitable material excavated from the benches shall be incorporated into the embankment.

(g) Constructing a pioneer layer

Where fill is to be constructed across water-logged or soft clayey ground exhibiting excessive movement under normal compaction equipment and haulage trucks, and such conditions

preclude the effective compaction of the bottom fill layers, the engineer may direct that a pioneer layer be constructed on the unstable ground. This layer shall be constructed by successive loads of suitable coarse material being dumped and spread in a uniform layer with a thickness just sufficient to provide a stable working platform for constructing the further fill layers which are to be compacted to a controlled density. Light hauling equipment shall be used, and, where necessary, end tipping for placing the material, and **the layer shall be** compacted by light compaction equipment being used, which will give the most effective compaction without the roadbed being overstressed. Pioneer layers will not require compaction to a controlled density.

(h) Construction of Drainage Blankets

Drainage blankets shall be constructed with natural filter material complying with the requirements of Clause 3107.

The surface on which the drainage blanket is to be constructed shall be smooth and even and the filter material shall be spread to an even thickness as required and lightly compacted with suitable rollers. The final surface of the drainage blanket shall be finished off true to line and level.

(i) Construction of high fills

The construction of high fills may require special techniques to prevent the development of excessive pore pressure and ensure the stability of such fills during and after construction. These may include, inter alia, the selection of better class material for use in the bottom layers of the fill, the construction of sand filter blankets and the strict control of moisture content during compaction. Where these measures are required, such fills shall be designated as high fills, which shall be constructed in accordance with the project specifications.

(j) Sand fill and sand filter blankets

Sand, which for the purposes of this requirement is specified as non- plastic sand with not less than 95% passing through the 4.75 mm sieve, but with not more than 20% passing through the 0.075 mm sieve, shall be compacted to 100% of modified AASHTO density. Should more than 20% pass through the 0.075 mm sieve, the sand shall be compacted to 95% of modified AASHTO density.

At the bottom of fills, and sometimes at intermediate levels, the construction of sand filter blankets may be required to facilitate the drainage of fills. Sand filter blankets shall be constructed in accordance with the details on the drawings and shall normally consist of a layer of selected sand with a suitable grading to provide effective drainage and to prevent the infiltration of fill or roadbed material into the sand filter blanket. The surface on which the sand filter blanket is to be constructed, shall be smooth and even and the sand shall he spread evenly to the required thickness and be given a light compaction with suitable rollers. The final surface of the sand filter blanket shall be finished off true to line and level.

The engineer may require the layers immediately below and above the filter blanket to be constructed from selected soil or gravel. Sand filter blankets will be measured and paid for separately.

(k) Construction of fills near structures

At all fills adjoining uncompleted structures such as bridges and large culverts, where the construction of the fill and the backfilling behind the structure cannot be done simultaneously, the fills shall be so constructed that the longitudinal slope of the surface of the fill at all stages will form a continuous plane sloping towards ground level at the structure at a gradient not exceeding 10%. When the structure is completed, the remaining portion of the fill shall be similarly completed simultaneously with the backfilling behind the structure, while the backfill behind the structure is being maintained at the same elevation as the adjoining fill. No additional payment will be made for constructing fills in this manner outside the restricted areas as defined in clause 8108

(l) Constructing toes for rook fill embankments

Where required rock fill embankments shall be protected by special toes which shall be installed as shown on the drawings and as directed by the engineer.

The toe shall be constructed simultaneously with the rest of the fill and shall consist of selected rock material varying in size between 150 mm and 750 mm. If shown on the drawings, a layer of synthetic-fiber filter material and a sand blanket shall be installed at the interface between the normal fill and the rock protection. Care shall be taken not to damage or tear such material.

The outer part of the toe shall consist of larger boulders properly bedded by means of smaller fragments so as to form a stable interlocking surface.

If placing with mechanical construction equipment does not achieve the required results, the equipment shall be supplemented by manual labour to select, bar and place keystones in between the larger boulders until the correct placing is achieved and the rocks are firmly interlocked.

No additional payment will be made for the supply and installation of synthetic - fibre filter material and sand blankets.

(m) Side Fill Material

Side fill shall be constructed to lines and cross sections described in the Contract and compacted to the highest density possible by the use of the spreading equipment.

(n) Trial Areas

Prior to the commencement of normal working the Contractor shall construct a trial area of not less than 500 square meters using the materials and equipment proposed for the work to demonstrate compliance with the requirements of this Clause.

4406 MEASUREMENT AND PAYMENT

When specified in the contract, embankments constructed will be measured and paid for in accordance with the terms set forth. Unless otherwise provided, embankments will not be paid for directly, but will be considered a necessary part of the work paid for under items included in the contract prescribed under Sections 203 and 204.

Item 44.01 widening of fills as specified in sub clause 4405 extra over

(a) Item 42.01(a) ..... cubic metre (m^3)

(b) Item 42.01(b) ..... cubic metre (m^3)

(c) Item 42.01 (c) Rock fill ..... cubic metre (m^3)

(d) Item 42.01 (d) Toes for rock fill embankments ..... cubic metre (m^3)

(e) Item 42.01 (e) Pioneer layer ..... cubic metre (m^3)

(f) Item 42.01 (f) Sand filter blanket ..... cubic metre (m^3)

The unit of measurement shall be a cubic metre of material placed in the widening of existing fills.

The tendered rates shall be paid extra over the rates applicable to normal full width construction, and shall include full compensation for all additional transport, equipment, labour, supervision as well as any additional costs for the widening of fills, including the cutting of benches.

The tendered rates shall also include full compensation for widening fills in restricted areas.

Item 44.02 Extra over item 42.03 for spoiling material excavated from benches constructed for widening existing fills. .....cubic metre (m^3)

The unit of measurement shall be a cubic metre of material excavated from benches in the widening of existing fills and which is spoiled on the instructions of the engineer.

The quantity shall be calculated in accordance with the authorized dimensions of the benches.

The tendered rate shall be paid extra over the rates applicable to item 42.03 and shall include full compensation for all additional costs for spoiling the material including amongst others all additional work, construction equipment, labour and supervision, irrespective of the size and depth of the benches and the class of material

No extra-over payment will be made for work in restricted areas

Item 44.03 Extra over sub item 42.01(c) for correcting rock fills that are deficient in fine material .....cubic metre (m^3)

The unit of measurement shall be the cubic meter of corrected rock fill.

The tendered rate shall include full compensation for procuring and furnishing approved material that passed through the 4.75 mm sieve, including all transport, for placing and spreading, watering and rolling, for removing all excess fines from the surface of the rock fill, and for all other incidentals necessary for completing the work as specified.

Item 44.04 Sand fills

Sand fills (as described in Sub-clause 4405(j), including free haul up to1.5 km):

(a) Non-plastic sand with up to 20% passing through the 0.075mm sieve compacted to100% of modified AASHTO density ..... cubic metre (m^3)

(b) Non-plastic sand with more than 20% passing through the 0.075 mm sieve compacted to 95% of modified AASHTO density ..... cubic metre (m^3)

The unit of measurement shall be the cubic metre of sand measured in fills as determined in item 42.01 but with the difference that no distinction will be made between different layer thicknesses in which the material is placed and compacted.

The tendered rates shall include full compensation for procuring, placing and compacting the sand fills as well as 1.5 km free-haul.

DIVISION 4500 : FINISHING OF SLOPES

4501 GENERAL

(a) Scope

This Division covers all work in connection with the trimming and finishing of slopes to cuttings and embankments.

(b) Dimensions

The dimensions shall be in accordance with the cross sections and details shown in the Contract or as instructed by the Engineer.

4502 CONSTRUCTION REQUIREMENTS FOR FINISHING OF SLOPES

(a) Equipment

Equipment used for the finishing of slopes shall be suitable for use on the surface to be finished.

(b) General

The slopes of cuttings and embankments shall be trimmed by hand or by approved mechanical means to remove loose material and to provide uniform slopes as described in the Contract or as instructed by the Engineer. Such trimming shall be completed prior to construction of the pavement.

Slopes of cuttings and embankments shall be finished to a uniform appearance. Except in solid rock, the tops and bottoms of all slopes shall be rounded unless otherwise directed by the Engineer. Slopes at transitions between cuttings and embankments shall be landscaped to merge one with the other. Slopes shall be adjusted, if required by the Engineer, to avoid unnecessary injury or destruction to standing trees and to harmonise with the existing landscape features. The transition to such adjusted slopes shall be gradual.

Slopes of cuttings and embankments which are flatter than 1 in 4 shall have a standard of finish that can be obtained by a motor grader.

4503 CUTTING SLOPES

The slopes of cuttings shall be trimmed to neat lines and to a standard that is generally attainable with proper care and workmanship in the type of material concerned. All loose rocks, stones, and other material shall be removed from the slopes. The final surface of slopes shall have a rough surface suitable for subsequent grassing or which will allow the natural vegetation to grow as described in the Contract.

4504 EMBANKMENT SLOPES

Embankment slopes shall be finished as described in the Contract. All loose rock and uncompacted material shall be removed. The final surface of the slope shall depend on the

nature of the embankment material but shall be as smooth as is consistent with the material used.

In the case of rock fill soft material shall be used to fill the interstices of the rock up to the surface of the slope.

4505 MEASUREMENT AND PAYMENT

Performance of work prescribed in this section is not payable directly but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit prices for performance of work under the other Earthwork payment items.

DIVISION 4600 : STABILIZATION

4601 SCOPE

This section covers the stabilization of materials used in the construction of the in-situ sub-grade, sub-base and road base by the addition of a chemical stabilizing agent or by the mechanical modification of the material by mixing various materials or by treating the material with a bituminous stabilizing agent. It includes the furnishing, spreading and mixing-in of the stabilizing agent or soil binder. In the case of chemically stabilized material the layer is given a curing treatment.

4602 MATERIALS

(a) Material to be stabilized

Material to be stabilised shall be any naturally occurring cohesive or non-cohesive soil or processed material, the properties of which can be permanently improved by the process of stabilisation to comply with the requirements of this Specification for the relevant material. It shall have a minimum coefficient of uniformity of 5.

(b) Chemical stabilizing agents

The stabilizing agent shall be either one or more of the following agents specified on the drawings, in the schedule of quantities or in the project specifications or ordered by the engineer.

(i) Road Lime

Road lime shall comply with the requirements of AASHTO M-216. The use of unslaked lime will not be permitted.

(ii) Ordinary Portland cement

Portland cement shall comply with the requirements of AASHTO M- 85, Type II or equivalent ISO standard class. The use of rapid-hardening Portland cement will not be permitted unless approved by the Engineer.

(iii) Soil binder

Soil binder for mechanical modification shall be taken from within the limits of an approved source and shall be subject to such requirements regarding grading, plasticity index or other properties, given in Division 5100, 5200 and 5400 or as may be indicated on the borrow-pit plans, or prescribed by the engineer.

(iv) Material for bituminous stabilization

Bituminous stabilizing agents

The bituminous stabilizing agent shall be one or more of the following agents as specified on the Drawings, in the Schedule of Quantities or in the project specifications, or as may be instructed by the engineer, and shall comply with the appropriate AASHTO specification given below:

Stable-grade bituminous emulsion: (60% net bitumen) AASHTO M- 140 (anionic) or AASHTO M-208 (cationic)

Fillers

Fillers such as road lime or Portland cement added for improving adhesion and/or stability shall comply with the requirements of sub-clause 4602(b) above.

Aggregate

Material for bituminous stabilization shall be subject to the requirements prescribed for chemically stabilized gravel or crushed-stone base, with the provision that the plasticity index shall not exceed 6 after the addition of chemical stabilizing agent (if required) and before stabilization.

In the case of gravel material, the percentage of material smaller than 0.075 mm shall not exceed 12%. No gravel from weathered igneous rock may be used, unless it is prescribed in the project specifications.

Where gravel material or crushed stone has been recovered from existing pavements, the engineer may allow up to 15% material smaller than 0.075 mm to be present in material intended for bituminous stabilization.

Where specified in the project specifications, material from existing pavements mixed with existing bituminous surfacing material may be used in bituminous stabilized base where so approved by the engineer, in writing. However, the material from existing surfacing shall not be more than 30% by volume, and no fragment shall be more than 37.5 mm in size.

(v) General

From the time of purchase to the time of use, all stabilizing agents shall be kept under proper cover and protected from moisture.

Consignments of these materials shall be used in the same sequence as they are delivered to the Works. Stocks, which may have been stored on site for longer periods than three months, shall not be used in the Work, unless otherwise authorized by the Engineer.

4603 CHEMICAL STABILIZATION

(a) Preparation of Layer

The material to be stabilized shall be prepared and placed as specified in the respective Divisions for sub grade, sub-bases and bases.

(b) Application of Stabilizing Agent

After preparation of the layer of soil or gravel, the stabilizing agent shall be spread uniformly over the full width of the layer by means of an approved type of mechanical spreader at the prescribed rate of application in a continuous operation or it may be spread by hand.

When spreading is done by hand, pockets or bags of stabilizing agent shall be accurately spaced at equal intervals along the section to be stabilized so as to provide the specified rate of application. The bags shall be opened and the stabilizing agent spread in transverse rows across the full specified width of stabilization. Such spreading shall be done as evenly as possible, and uniform distribution of the stabilizing agent over the entire surface to be treated

shall then be obtained by leveling-off the rows of stabilizing agent by means of hand rakes and/or screeds.

The Engineer may permit spreading of the hand spotted stabilizing agent by means of motor grader, provided he is satisfied that an even distribution of stabilizing agent is obtained.

(c) Mixing in of stabilizing agent

Immediately after the stabilizing agent has been spread, it shall be mixed with the material for the full depth of treatment. Care shall be exercised not to disturb the compacted layer underneath, nor to mix the agent below the desired depth. Mixing shall be continued and repeated as often as may be required to ensure a thorough, uniform and intimate mix of the soil or gravel and stabilizing agent over the full width and depth of material to be treated and until the resulting mixture is homogeneous and of uniform appearance throughout. Mixing should be completed as quickly as possible.

Mixing shall be done by grader, disc harrow, rotary mixer or equivalent plant. Working over the full area and depth of the layer to be stabilized by means of successive passes of the equipment

Mixing may also be done in central batch-mixing plants, but the contractor will not be entitled to payment for additional overhaul or incidentals resulting from such procedure.

(d) Watering

Immediately after the stabilizing agent has been properly mixed with the material, the moisture content of the mixture shall be determined and the required amount of water. The amount of water to be added shall be sufficient to bring the mixed material to the optimum moisture content for the compaction equipment used and the density required in the respective Divisions for sub grade, sub-bases and bases.

Each application or increment of water shall be well mixed with the material so as to avoid concentration of water near the surface or flow of water over the surface of the layer.

Particular care shall be exercised to ensure uniform and satisfactory moisture distribution over the full depth, width and length of the section being stabilized and to prevent any portion of the work from getting excessively wet after the stabilizing agent has been added. Any portion of the work that becomes too wet after the stabilizing agent has been added and before the mixture has been compacted will be rejected and such portions shall be scarified, re-stabilized, re-compacted and again finished off in accordance with the requirements herein specified, all at the expense of the Contractor.

The water supply and watering equipment shall be adequate to ensure that all water required is added and mixed with the material being treated within a short enough period to enable compaction and finishing to be completed within the period specified in Sub-clause 4603(H) below.

(e) Compaction

The Compaction provisions of the respective Divisions for sub grade, sub-bases and bases shall apply.

During compaction, loss of moisture through evaporation shall be corrected by further light applications of water. At the completion of the primary compaction the surface shall be cut to the finished level and all cuttings removed from the surface before final rolling.

Final rolling shall be done with equipment that will give a smooth surface conforming to the surface tolerance specified. The minimum compaction requirements shall be as specified for the particular layer in the various Divisions of these Specifications.

A sufficient number of compacting units shall be employed on the work to ensure that from the time the stabilizing agent is first applied to the layer, the process of mixing, applying water, compaction, shaping and final finishing, is completed within the periods specified in Sub-clause 4603(h) below.

Vibrating rollers will only be used with the written approval of the Engineer.

(f) Finishing at Junctions

Any finished portion of the stabilized layer adjacent to new work, and which is used as a turn-around area by equipment in constructing the adjoining section, shall be provided with a protective cover of soil or gravel at least 100 mm in thickness over a sufficient length to prevent damage to work already completed.

At the time of final finishing of the adjoining section, such cover shall be removed to permit the making of a smooth joint at the junction of the different section.

Material in the vicinity of the joint, which cannot be processed satisfactorily with normal construction equipment, shall be mixed and compacted by hand or with suitable hand-operated machines.

(g) Curing of Stabilized Work

The stabilized layer shall be protected against rapid drying out for at least seven days following completion of the layer.

The methods of protection may be any one or more of the following:

1) Immediately following completion, the stabilized layer shall be kept continuously wet or damp by spraying with water at frequent intervals. This method will be permitted for up to a maximum period of 24 hours after which time one of the methods (2), (3), or (4) must be applied. The Contractor is warned that the Engineer in his sole discretion may reject work that is not kept continuously wet or damp but subjected to wet-dry cycles.

2) The stabilized layer shall be covered with the material required for the layer on top thereof whilst the stabilized layer is still in a wet or damp condition. The material forming the protective layer shall be watered at such intervals as may be required to keep the stabilized layer continuously wet or damp, and in dry weather this shall be done at least once in every 24 hours.

3) The layer shall be covered with an approved curing membrane applied at the rate directed by the Engineer.

4) Where bituminous surfacing is specified on top of the stabilized base or sub-base, the prime or tack coat together with the first application of bituminous surfacing may be utilized as a curing membrane and shall be applied as specified in Division 6100 of these Specifications.

5) The stabilized layer shall be kept continuously wet for seven days by an effective fog-spraying system that will not damage the surface of the layer or by any other system approved by the Engineer. During this period the application of water shall be so controlled that it will not unduly wet the layer but at the same time will not allow the layer to dry out. Layers

allowed to dry out may be rejected if damaged thereby. In regard to this method payment will be made only for the application of water.

No additional payment will be made for curing as described above except that the application of a curing membrane or water in accordance with method (5) above will be paid for when the application of such methods has been ordered by the engineer.

(h) Construction Limitations

The stabilizing agent shall only be applied to such an area that all processing, watering, compacting and finishing can be completed within the period stated hereunder:

Table 4600/1 Maximum time for completion in stabilization

Stabilizing Agent	Maximum time for completion after stabilizing agent comes into contact with the material to be stabilized.
Ordinary Portland cement, and/or approved Portland cement blends	8 hours
Lime	10 hours

No stabilizing agent shall be applied when the moisture content of the material to be stabilized exceeds the optimum moisture for the compaction equipment proposed by more than 2% of the dry mass of the materials.

No stabilization shall be done during wet weather or when, in the opinion of the Engineer, windy conditions may adversely affect the stabilizing operations.

Any rain falling on the working area during the process of stabilization may be sufficient cause for the Engineer to order such areas as are affected to be reconstructed at the Contractor's own cost.

No traffic or any equipment not actually used in the processing of the layer shall be allowed to pass over the freshly spread stabilizing agent. Only equipment required for curing or priming shall be allowed over the treated layers during the specified curing period.

4604 MECHANICAL MODIFICATION

Mechanical modification shall consist of the addition of an approved soil binder to material to improve its properties, or the mixing of material originating from various sources, as described hereafter.

(a) Modifying soil and gravel by the addition of a soil binder

The modification of soils and gravels, by the addition of a soil binder [4602 (b)], shall consist of the addition of an approved soil binder to the material, in order to improve the properties of the material.

This process involves the addition and mixing of an approved soil binder, which shall not exceed 20% by mass of the total mixture, to the material to be improved.

The material to be treated shall be prepared and spread to the required loose thickness as specified in the respective Divisions for sub grade, sub-bases and bases.

An approved binder material shall then be spread over the prepared material at the required rate, and the materials shall be mixed by a suitable method by motor grader, disc harrow and/or other suitable plant until the binder material is uniformly and intimately mixed with the material being treated.

The mixed materials shall then be watered, mixed and compacted as described in the respective Divisions for sub grade, sub-bases and bases.

(b) Mixing materials from various sources

The mixing of materials from various sources requires the material from the first source to be dumped onto the road, prepared, broken down and spread in a layer of uniform thickness, after which it is lightly rolled with a steel-wheeled roller.

The material from the second source shall then be dumped onto the road, prepared, broken down and evenly spread, after which the two materials shall be thoroughly mixed.

The mixing of materials from different sources will apply only when the smallest component of the mixture exceeds 20% of the total mass of the mixture. If not, the process will be regarded as the addition of a soil binder as described above in sub-clause (A).

(c) Recombining recovered material

Where specified in the project specifications or required by the Engineer, recovered material shall be recombined to comply with the requirements of the layer for which it is destined.

4605 BITUMINOUS STABILIZATION

(a) Preparing the material

The material to be stabilized shall be prepared and placed as specified in the respective Divisions for sub grade, sub-bases and bases, and shall be ploughed into furrows.

The moisture content of the material shall be just below the optimum moisture content during mixing-in of the stabilizing agent. Immediately before the stabilizing agent is applied, the material shall again be lightly wetted. No dry material whatsoever may then be present.

(b) Mixing in the additive

Where an additive (lime, cement, etc.) has been specified, or if so required by the engineer, it shall first be spread and mixed in as described in Sub-clause 4603(c). Separate payment will be made for providing, applying and mixing-in the additives.

(c) Heating and diluting the bituminous stabilizing agent

The bituminous stabilizing agent shall be heated as specified in Division 6300. During dilution of the bituminous emulsion with water, care shall be taken to prevent its breaking. This will mean that clean water shall be added gradually during constant stirring of the emulsion or its circulation by pumps.

(d) Applying the stabilizing agent

After preparing the material, the stabilizing agent shall be uniformly applied by an approved binder distributor in a continuous process at the prescribed rate of application over the full area of the layer.

Multiple applications may be necessary. In such cases it shall be ensured that the moisture escaping on account of drying-out is replaced by water being applied. Care shall be taken not to allow the stabilizing agent to run from the layer before it has been mixed in.

The stabilizing agent shall be diluted with water to obtain a better distribution.

In cases where, in the opinion of the Engineer, it is impracticable to apply the stabilizing agent by mechanical binder distributor, hand distributors may be used.

Where so required by the Engineer, a certain part (not more than 10% of the total quantity) of the stabilizing agent shall be sprayed onto the surface in a diluted form (with a maximum of 2 parts of water to 1 part of bituminous stabilizing agent) immediately, before the final finishing of the layer.

The stabilizing agent shall, immediately after each application, be mixed with the loose material, to the full depth of the treated layer. This work shall be done carefully so as not to disturb the underlying compacted layer and as not to mix in the stabilizing agent deeper than the required depth.

During mixing-in, the moisture content of the material shall be immediately below or at optimum moisture content.

Mixing shall be proceeded with for so long as may be necessary and shall be repeated as frequently as may be necessary to ensure the thorough, uniform and proper mixing of the gravel or the aggregate and the stabilizing agent over the full surface and depth of the material to be treated, until the resulting mixture is homogeneous and has the same appearance throughout, without any individual spots of the stabilizing agent being visible, and until the mixture has reached the required moisture content of compaction.

Mixing shall be done by road grader, disc harrow, rotary mixer or similar plant, which will work the layer to be stabilized by way of successive passes over its full surface and depth.

Mixing may also be done in a central batch-mixing plant, but the contractor shall not be entitled to payment for extra overhaul or other costs arising from this method of work.

(e) Compaction

The provisions of sub-clause 4603(e) shall apply.

The moisture content during the compaction of stabilized layers shall not exceed the optimum of the gravel or aggregate. However, the Engineer may amend these required moisture contents.

Where the required densities for a pavement layer in accordance with AASHTO density is specified, the field densities shall be determined on the material as obtained from the road, and the field densities shall not be adjusted on account of the presence of bituminous stabilizing agents.

(f) Finishing at Junctions

The junctions of sections shall be finished in accordance with sub-clause 4603(f) for obtaining an even and well-compacted joint and so as not to cause damage to the adjacent parts of the sections.

(g) Construction limitations

When gravel is being stabilized with a bituminous emulsion, the layer shall be mixed and compacted within 24 hours.

Limited slushing shall be done within 48 hours.

Where crushed stone is stabilized with bituminous emulsion and used for repairing sub-base or base layers, it shall be mixed in, placed, and compacted within 5 hours.

4606 CONSTRUCTION TOLERANCES

(a) Rate of Application

The average rate of application of **chemical stabilizing agents**, when applied by mechanical bulk spreading equipment and measured by the "canvas patch" or "trays" method, shall be equal to the specified rate of application $\pm$ 5% measured over any section not exceeding 1.0 km in length and no single measurement shall show a value of more than 20% below the specified rate.

When hand spotted, stabilizing agents shall be spread exactly to the specified rate of application.

The average rate of application of a **bituminous stabilizing agent** as measured in the binder distributor shall be within 5% of the specified rate of application.

(b) Uniformity of mix

The cementitious binder content of the mixed material as determined on 50 samples per lot when sampled and tested as specified by the Engineer, shall be within the following limits:

The average cementitious binder content of all 50 samples shall not be less then 95% of the specified binder content.

Not more than 9 samples out of the 50 shall show a cementitious binder content lower than 70% of the specified binder content.

The test results shall be adjusted to allow for the presence, in the material to be stabilized, of minerals that affect the test results. The above requirements for uniformity of mix shall only be applied provided that the variation in these adjustments is within the specified limits.

4607 CONSTRUCTION OF TRIAL SECTION

Before the Contractor commences with the construction of stabilized layers, he shall demonstrate by constructing a trial section that the equipment and procedure he proposes to use will result in him constructing the layers in accordance with these specifications.

The trial section shall be at least 2,000 m^2 in area and shall be constructed in its proper position in the pavement. Only when such a trial section has been satisfactorily constructed

and accepted will the contractor be permitted to proceed with the stabilized layer in the permanent work.

In the event of the trial section being unsuccessful, the Contractor shall remove the trial section should the engineer so require.

The trial section shall be paid for separately only when it complies with all the requirements of these specifications and has been approved by the Engineer.

After approval has been obtained, the mixing process and equipment shall remain unaltered unless otherwise approved by the Engineer.

4608 STABILIZATION WORK IN RESTRICTED AREAS

(a) General requirements

Suitable equipment and methods acceptable to the Engineer shall be used in restricted areas so that the required densities will met throughout the thickness of the layer. If necessary, the layers shall be placed in thicknesses, which are less than the specified layer thickness.

Where existing and new work are joined (longitudinal joints - and others) material shall be satisfactorily mixed and compacted without any permeable or loose patches.

In regard to the curing of stabilized layers in restricted areas the construction of the subsequent layers may be commenced as soon as practicable with the permission of the engineer.

(b) Chemical stabilization

Where pavement layers are to be widened no chemical stabilizing agent may be spread or mixed beyond the required width.

The contractor will not be permitted to mix material for stabilization on adjacent surfaces unless he has obtained prior permission from the engineer in writing.

Where the existing surfaces of the road may not be used for this purpose the contractor shall apply other approved methods of mixing.

Payment over and above payment for work in restricted areas will not be considered for additional overhaul or other - costs arising from this manner of mixing or working.

(c) Bituminous stabilization

No mixing of material with bituminous stabilizing agent will be permitted on the existing surfacing without the written permission of the engineer, and then only where such surface is required to be resealed or provided with a resurfacing layer.

Where restricted areas are such that mixing in them will not be practicable and/or mixing on adjacent surfaces is not permitted, mixing shall be done in a central mixing plant. In the case of smaller quantities, approved concrete mixers may be used.

Payment over and above payment for work in restricted areas will not be considered for additional overhaul or other costs arising from this manner of mixing or working.

4609 QUALITY CONTROL

(a) Process Control

(i) Stabilizing Agent

The Contractor shall keep detailed records of the quantities of stabilizing agent applied to the road and the volumes of material stabilized, and make these records available to the Engineer.

The Contractor shall also monitor the rate of application when using bulk-spreading equipment by taking a canvas patch or tray every 200 m, unless, with the Engineer's permission, this may be reduced.

When using a bulk spreader on site the first time or after it has been adjusted or repaired, spread rate shall be checked by at least five tests over a short distance as practicable with the equipment running at normal speed without stops. Spreading shall not continue on a large scale until the spread rate is within allowable tolerances.

(ii) Compaction

The requirements for process control in respect of compaction shall be the same as stated for the unstabilized layers in each section. Densities shall be determined as described in AASHTO T 180.

Unless noted otherwise the top 600 mm of embankment/ fill shall be compacted to 95 % of the maximum density, as determined by the test method given in (ii-1) above, and all material below the top 600 mm shall be compacted to 90 % of the maximum dry density.

(b) Routine Inspection and Testing

Routine inspections will be carried out by the Engineer to test the quality of materials and workmanship for compliance with the requirements of this Division.

Compliance with the requirements for the compaction of stabilized materials shall be as specified in the relevant section for each layer.

The requirements for uniformity of mix and rate of application shall be deemed to have been complied with if the mixture meets with the requirements of Clause 4606.

When the tests for uniformity of mix are not applicable as stated in Sub-clause 4606(B), the material shall be visually appraised for uniformity of mix.

(c) Defective Work or Materials

Any materials or work which do not comply with the requirements specified, shall be removed and replaced with new materials or work complying with the specified requirements

OR

If the Engineer permits, shall be repaired as specified in Clause 1208, so that after being repaired it will comply with the specified requirements.

In cases where, in the opinion of the engineer it is impracticable to apply the stabilizing agent by mechanical binder distributor, hand distributors may be used.

4610 MEASUREMENT AND PAYMENT

Items 46.10, 46.11 and 46.12 are applicable solely to stabilization work that has to be executed in a restricted area of which the width is less than 3.0 m or the length is less than 150.0 m.

Item 46.01 Chemical stabilization (layer thickness indicated) extra over unstabilized compacted layers (layer to be stabilized indicated).....cubic meter (m3)

The unit of measurement shall be the cubic metre of stabilized material, the quantity of which shall be determined in accordance with the authorized dimensions of the layers treated as instructed by the engineer.

The tendered rates for chemical stabilization shall be paid as extra over the rates tendered for constructing the unstabilized layers. The tendered rates shall therefore include full compensation for spreading and mixing the stabilizing agent, curing the stabilized sections, any extra water required, and all materials, supervision, labour, plant, equipment, tools and incidentals (extra over those provided for in the rates tendered for constructing the unstabilized layer) necessary for completing the specified work, but excluding the cost of supplying the stabilizing agent. No distinction will be made in respect of the type of stabilizing agent used, the time for completion or the specific layer being stabilized, and the extra over rate tendered shall apply to any combination thereof. The engineer reserves to himself the right to vary the thickness of the layer to be stabilized by up to 20 mm, and the contract rate for this work shall not be amended by such change.

Item 46.02 Chemical stabilizing agent:

(i) Ordinary Portland cement. .....ton (t)

(ii) Portland blast-furnace cement.....ton (t)

(iii) Road lime (type indicated). .....ton (t)

(iv) Other stabilizing agents (type specified).....ton (t)

The unit of measurement shall be the ton of stabilizing agent. Measurement shall distinguish between the various stabilizing agents used. When mixtures of cement or lime are used, the quantity of each constituent shall be measured separately and not the mixture as a whole.
The quantity will be determined in accordance with the authorized rate of application.

The tendered rates shall include full compensation for providing the stabilizing agent at the works, irrespective of the rate of application specified or ordered by the engineer, but shall make allowance for the differences in mixing and compaction times specified for various stabilizing agents.

Item 46.03 Mechanical modification (extra over untreated layer):

(i) By adding a soil binder.....cubic meter (m^3)

(ii) By mixing materials from different sources..... cubic meter (m^3)

The unit of measurement shall be the cubic meter of compacted material that has been mechanically modified as specified in clause 4604, and the quantity shall be calculated in accordance with the authorized dimensions of the mechanically modified layer.

The tendered rates for mechanical modification shall be paid as extra over the rate for the construction of an untreated layer and shall include full compensation for all the work, plant and other incidentals necessary for supplying and hauling the material for a distance of 1.0

km, and for spreading the soil binder and mixing it with the material to be treated or for mixing materials from different sources as specified.

The addition of material during a crushing or screening process, whether it is specially imported material, which is not the product of the crushing process or whether it is crushed material screened out and then replaced in part or as a whole, will not be regarded as treatment with soil binder for measurement and payment purposes but will be regarded as part of the process of producing crushed stone for sub-base, base or other construction work. The cost of which shall be included in the tendered rates for those items of work.

Item 46.04 Provision and application of water for curing.....kilolitre (kl)

The unit of measurement shall be the kilolitre of water provided and applied in accordance with the engineer's instructions for curing the stabilized layer as specified in sub-clause 4603(g)(5).

The tendered rate shall include full compensation for furnishing, transporting and applying the water and for the provision of spraying equipment. Water applied within the first 24 hours of completion of the stabilized layer will not be calculated for payment.

Item 46.05 Curing by covering with the subsequent layer. .....square meter (m2)

The unit of measurement shall be the square meter of stabilized pavement layer being cured by covering it with the subsequent layer as specified in sub-clause 4603(g)(2). The quantity will be determined by the authorized dimensions of the layer to be treated.

The tendered rate shall include full compensation for incidentals in respect of applying the subsequent layer for curing as specified, including the cost of regularly supplying and applying water.

Item 46.06 Bituminous stabilization (extra over the untreated layer) .... .cubic meter (m3)

The unit of measurement shall be the cubic meter of material stabilized: the quantity shall be determined in accordance with the authorized dimensions of the completed layer.

The tendered rate for bituminous stabilization shall be paid extra over the rates for constructing the untreated layer and sha11 include full compensation for all incidentals, excepting the compensation covered by items 46.07 and 46.08, which are necessary for treating the material as specified. No distinction shall be made in regard to the type of bituminous stabilizer used, the time for completion, and the particular layer to be stabilized and the tendered extra rate shall apply to any combination thereof. The engineer reserves to himself the right to alter the thickness of the layer to be stabilized, and the contract rates will remain applicable to all layer thicknesses between the limits of 100 mm and 200 mm.

Item 46.07 Bituminous stabilizing agent:

(i) Anionic stable grade bituminous emulsion (60% net bitumen)..... liter *(l)*

(ii) Cationic stable grade bituminous emulsion (60% net bitumen) ..... liter *(l)*

(iii) Other (specify). ..... liter *(l)*

The unit of measurement shall be the liter of bituminous stabilizing agent applied on the instruction of the engineer.

The tendered rates shall include full compensation for providing, diluting and applying the stabilizing agent, irrespective of the prescribed rate of application.

Item 46.08 Additive for bituminous stabilization:

(i) Ordinary Portland cement. ..... .ton (t)

(ii) Road lime ....ton (t)

The unit of measurement shall be the ton of additive applied on the Instruction of the engineer.

The tendered rates shall include full compensation for providing and spreading the additive and for the incidentals required for mixing it in. The tendered rates shall apply irrespective of the percentage of additive prescribed between the limits of 0.5% and 1.5% by mass.

Item 46.09 Extra over item 46.01 for chemical stabilization in restricted areas:

(i) Mixing in mechanical mixers. ..... cubic meter (m^3)

(ii) In situ mixing..... cubic meter (m^3)

(iii) Mixing as for in situ mixing but on adjacent surfaces. ..... cubic meter (m^3)

Item 46.10 Extra over item 46.03 for mechanical modification in restricted areas:

(i) Mixing in mechanical mixers ..... cubic meter (m^3)

(ii) In situ mixing ..... cubic meter (m^3)

(iii) Mixing as for in situ mixing but on adjacent surfaces ..... cubic meter (m^3)

Item 46.11 Extra over item 46.06 for bituminous stabilization in restricted areas:

(i) Mixing in mechanical mixers. ..... cubic meter (m^3)

(ii) In situ mixing..... cubic meter (m^3)

(iii) Mixing as for in situ mixing but on adjacent surfaces ..... cubic meter (m^3)

The unit of measurement shall be a cubic meter of chemically stabilized or modified material, mechanically modified material, or bituminous stabilized material in restricted areas measured in place after placement irrespective of the layer treated. Payment shall apply only to bases, sub-bases and selected layers.

The tendered rates shall include full compensation for all additional costs for executing the work in restricted areas, and shall amongst others include full compensation for the additional costs for applying stabilizing agents or soil binders in restricted areas, as well as for curing chemically stabilized layers in restricted areas (irrespective of the method of curing), and the application of additives for bituminous stabilization in restricted areas.

Payment under item 46.09 will not distinguish between the various types of chemical stabilizing agents.

Payment under item 46.10 will not distinguish between the addition of soil binder and the mixing of material from various sources.

Payment under item 46.11 will not distinguish between the various types of bituminous stabilizing agents or various types of additives.

Item 46.12 Extra over items 46.01 and 46.06 for trial sections. .....cubic meter (m3)

The unit of measurement shall be the cubic meter of compacted stabilized layer that has been placed as a trial section and approved by the engineer.

The tendered rate shall include full compensation for all additional work, testing and incidentals associated with the construction of an approved trial section as specified. It shall also include full compensation for trial sections removed as excess/unsatisfactory material.