Volume (II)

2008

Jordanian National Building Council

THE HASHEMITE KINGDOM OF JORDAN

SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION

Volume (II)

PART (2) : Earth Works
PART (3) : Sub-base & Base Courses
PART (4) : Bituminous Construction

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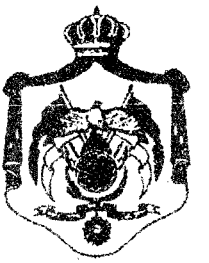
THE HASHEMITE KINGDOM OF JORDAN

Ministry of Public Works & Housing

Directorate of Planning & Development



Specifications for Highway and Bridge Construction

Volume (II)

Part (2): Earth Works
Part (3): Sub-base & Base Courses
Part (4): Bituminous Construction

1991

PREFACE

This book contains the new and updated standard specifications for construction of Roads and Bridges. This updating maintains the original specifications issued in (1974), but has drawn extensively on experience gained in road construction in Jordan and other Middle East countries. The appropriate standard Specifications from AASHTO. and ASTM. as well as the British Standards have been used to form the basis of this document standard specifications; the Saudi Arabia, and Kuwait standards have also been referred to, where similar conditions prevail. For some sections of the specifications it was necessary to draw upon specialist services for information, for example from Federal Bureau of Highway, Asphalt Intstitue, Concrete Institute (ACI), Jordan Oil Refinery, Cement factory and other local specialized technical corporations.

This new book of specifications was prepared by Dar Al-Handasah Consultants (Shair & Partners) and was reveiwed by various technical committees manned by engineers of diversified experience from the Ministry of Public Works & Housing, Professional Associations, Local contractors and consultants.

This book contains specifications for those items of works, materials and construction methods that are generally applicable to the Ministry of Public Works & Housing contracts, but it is adaptable for use by other agencies.

This standard specifications constitute the master volume which consists of (8) parts as follows:

Part 1: General Provisions
Part 2: Earthworks
Part 3: Sub-base & Base Courses
Part 4: Bituminous Construction
Part 5: Concrete, Steel & Structures
Part 6: Lighting, Traffic Signals & Electrical Installations
Part 7: Landscaping & Irrigation
Part 8: Incidental construction

The master volume (8 Parts) is sub divided into four volumes as follows:

Volume I : Part 1
Volume II : Part 2, Part 3, Part 4
Volume III : Part 5
Volume IV : Part 6, Part 7, Part 8

The Arabic translation for this specification is available at MPWH.

In this occasion, I would like to affirm my gratitude to those contributed to the preparation, revision and issuance of this general standard specifications. I believe that such specifications shall actively develop the constructions sector with the directions of the government under the leadership of His Majesty King Hussain.

Minister of Public Works & Housing
Eng. Sa'ad Hayel Srour

S. Srour

بسم الله الرحمن الرحيم

مقدمـــة

يحتوي هذا الكتاب على مواصفات قياسية محدثة للطرق والجسور ويحافظ هذا التحديث على المواصفات القياسية الصادرة عام ١٩٧٤. غير أنه يعتمد بشكل رئيسي على الخبرة المكتسبة في إنشاء الطرق في الأردن وبلدان أخرى في منطقة الشرق الأوسط. وقد استخدمت هنا المواصفات القياسية الملائمة من AASHTO، ASTM، والمواصفات البريطانية لتكون أساساً لهذه المواصفات المحدثة. كما تم الإستعانة ايضاً بالمواصفات القياسية السعودية والكويتية أينما كانت الظروف السائدة مشابهة لظروف الأردن. وقد كان من الضروري في بعض اقسام هذه المواصفات جلب خدمات مختصين لتوفير المعلومات، ومثال ذلك المكتب الفيدرالي للطرق (FEDERAL BUREAU OF HIGHWAY) ومعهد الاسفلت (ASPHALT INSTITUTE) ومعهد الخرسانة (ACI) وشركة مصفاة البترول الاردنية، وشركة مصانع الاسمنت، ومؤسسات محلية أخرى فنية ومختصة.

وقد أعدت هذه المواصفات من قبل السادة دار الهندسة للتصميم والإستشارات الفنية (شاعر ومشاركوه) وتمت مراجعتها من قبل عدة لجان فنية مختصة شكلت من مهندسين ذوي خبرة من الأجهزة العاملة في وزارة الأشغال العامة والإسكان، ومن النقابات المهنية المختصة والشركات الإستشارية والمقاولين المحليين.

يشتمل هذا الكتاب أيضاً على المواصفات الخاصة ببنود الأعمال والمواد وطرق الانشاء التي يمكن تطبيقها بشكل عام على اتفاقيات ومشاريع وزارة الأشغال العامة والاسكان، وهي قابلة ايضاً للإستعمال من قبل مؤسسات أخرى في المملكة.

ان هذه المواصفات قد جمعت في مجلد رئيسي واحد يحتوي على ثمانية أجزاء هي:

الجزء (١) اعتبارات عامة.
الجزء (٢) الاعمال الترابية.
الجزء (٣) طبقات الأساس وما تحت الاساس.
الجزء (٤) الاعمال الاسفلتية.
الجزء (٥) المنشآت الخرسانية والمعدنية.
الجزء (٦) الإنارة، الإشارات المرورية، والتركيبات الكهربائية.
الجزء (٧) تجميل الموقع والري.
الجزء (٨) إنشاءات متنوعة.

وقد قسم المجلد الرئيسي المؤلف من (٨) أجزاء إلى المجلدات الفرعية التالية:

مجلد (١) الجزء الأول.
مجلد (٢) الأجزاء الثاني، الثالث والرابع.
مجلد (٣) الجزء الخامس.
مجلد (٤) الاجزاء السادس، السابع والثامن.

وتتوفر في وزارة الأشغال العامة والاسكان الترجمة العربية لهذه المواصفات.

وفي هذه المناسبة، أود ان اقدم عظيم امتناني لجميع الذين ساهموا في إعداد هذه المواصفات القياسية ومراجعتها وإصدارها، مؤكداً أن مثل هذه المواصفات ستعمل على تطوير قطاع الإنشاءات بشكل فعّال وتلبي تطلعات الحكومة الرشيدة في ظل قيادة صاحب الجلالة الملك الحسين.

والله ولي التوفيق،،،

وزير الأشغال العامة والإسكان
المهندس محمد عقيل البدري

Part (2)

Earthworks

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SECTION 4.10 (Cont)

SECTION 2.01: CLEARING AND GRUBBING

2.01.1 SCOPE

1. These Works shall consist of the removal and satisfactory disposal of all vegetation, surface debris and scattered stones and rocks within the limits of the right-of-way (ROW), easement areas and borrow pits (except items designated to remain or which are to be removed at a later stage of the Works).

2. Removal of structures and similar obstructions and removal of utilities shall be as specified in Section 2.02 - "Removal of Obstructions and Utilities".

2.01.2 CONSTRUCTION

1. The Contractor shall set out the approved construction limits and the Engineer will designate all trees, shrubs, plants, vegetation, etc and other items to remain within the ROW. The Contractor shall carefully preserve all such items from damage or defacement.

2. All surface objects, trees, stumps, roots, stones and rocks (up to 0.2 cu.m. or 500 kg individual size or weight), and other protruding obstructions, not designated to be retained, shall be cleared or grubbed to ground level. In case of trees of one meter or less girth should be removed entirely or at least one meter below ground level or as instructed by the Engineer.

3. In areas to be rounded at the top of cut slopes, stumps shall be cut off below the surface of the final slope line.

4. Grubbing along the lines of proposed channels and ditches shall be taken below final excavated elevations.

5. Stump holes and other holes from which obstructions are removed within the ROW of construction, shall be backfilled with suitable material and compacted in accordance with Section 2.06 - "Embankment Construction", and those holes which are outside the ROW shall be filled to the adjacent level.

6. Perishable material shall be burned under the constant care of competent watchmen at such times and in such a manner that any vegetation or other items designated to remain in the ROW, or other adjacent property, will not be jeopardized. Burning shall be carried out in accordance with applicable laws and ordinances.

7. Materials, stones, rocks, and debris which cannot be burned and perishable materials, shall be removed from the ROW and disposed of at approved dumping areas off the Site, provided permission of the respective property owners has been obtained in writing to dump such materials on their land. Where designated on the drawings, the Contractor shall make all necessary arrangements with property owners for obtaining written permission to dispose of materials, at his own expense.

2.01.3 MEASUREMENT

1. The Works prescribed in this Section shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for Pay Items.

SECTION 2.02: REMOVAL OF OBSTRUCTIONS AND UTILITIES

2.02.1 SCOPE

1. The Works shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, abandoned pipelines, and any other obstructions, as shown on the Drawings, which are not designated or permitted to remain, except for any obstructions as shown on the Drawings which are to be removed and disposed of at a later stage of the Works. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes and pits.

2. The Contractor shall examine the Site and record all obstructions and utilities at the commencement of the Works, as specified in Subsection 1.03.6 - "Existing Utilities and Other Obstructions".

2.02.2 CONSTRUCTION

1. General

1.1 The Contractor shall raze, remove and dispose of all buildings, foundations, structures, fences and other obstructions, any portions of which are on the ROW, except utilities and items for which other arrangements for removal have been made. All designated salvageable material shall be removed, without causing unnecessary damage, and in sections or pieces which may be readily transported, and shall be stored by the Contractor at approved locations, for later use or possession of others.

1.2 Unusable perishable material shall be destroyed. Non-perishable material may be disposed of off the Site, provided permission of the respective property owners has been obtained in writing to dump such materials on their land.

1.3 Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted to the type of compaction within the range for the adjacent roadway embankment as specified in Section 2.06 - "Embankment Construction".

1.4 Salvaged pipe culverts and other re-usable structures shall be stored at accessible approved locations on Site and shall become the property of the Employer.

2. Removal of Bridges, Culverts and Ditches

2.1 Bridges, culverts and other drainage structures in locations traversed by traffic shall not be removed until approved arrangements have been made by the Contractor to maintain the flow of traffic.

2.2 Substructures shall be removed down to the elevations of the natural stream bed. Those parts outside the stream shall be removed 300 mm below

natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed to the extent necessary to accommodate construction of the proposed structure.

2.3 Steel bridges and timber bridges, designated to be salvaged, shall be dismantled without causing unnecessary damage. Steel members shall be match marked, unless this requirement is waived by the Engineer. All salvaged material shall be stored as previously specified for reuse or possession of others.

2.4 Blasting or other operations necessary for removal of existing structures or other obstructions, and which may damage new construction in the vicinity, shall be completed prior to commencing the new construction.

3. Removal of Pipes

3.1 All pipes unless otherwise directed shall be removed and precautions taken to avoid breaking or damaging the pipes. The Contractor shall exercise utmost care during the removal of pipes so as to avoid unnecessary damage.

4. Removal of Rocks and Boulders

4.1 Large rocks and boulders of individual size greater than 0.2 cu.m or greater than 500 kg in individual size or weight which lie within the limits of the Works, shall be removed and disposed of as directed.

5. Removal of Fences and Gates

5.1 When fences and gates enclosing pasture land or farm land are to be removed, the Contractor shall notify the Engineer sufficiently in advance to permit the property owner reasonable time to construct alternative fencing or make other suitable arrangements.

6. Removal of Wells

6.1 Existing wells, abandoned or active, which lie within the limits of the Works, as shown on the Drawings, shall be dismantled, backfilled, and compacted. All salvageable materials shall be removed and stored at approved locations on Site. All salvageable material shall become the property of the Employer. Wells shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted after obtaining the Engineer's permission to the type of compaction within the range designated.

7. Removal of Utilities

7.1 The Contractor through the Engineer shall notify all Utility Owners and co-operate with them in respect of removals and relocations.

7.2 Unless shown otherwise on the Drawings, realignment or relocation of active Utilities will be the responsibility of the respective Owners and such Works will be coordinated by the Employer.

7.3 The removal of all disconnected or abandoned Utilities within the ROW shall be carried out by the Contractor, unless the Utility Owner indicates his intention to carry out such removal and the salvaging of materials, fittings, parts, etc.

7.4 The Contractor through the Engineer shall advise each affected Utility Owner in writing of his proposed construction schedule and liaise with the Employer who will arrange for inspection by the Utility Owners and interruption or disconnection of the Utilities as appropriate.

7.5 The Contractor shall be responsible for supporting and protecting realigned Utilities, and existing Utilities that are to remain in place, for the duration of the Contract and shall provide all necessary Temporary Works in this respect. Any damage caused to Utilities and attributable to the Contractor shall be repaired at his expense.

7.6 All excavation and backfill shall conform with the requirements of Section 2.06 - "Embankment Construction" and Section 2.09 - "Excavation and Backfill for Structures", as appropriate.

2.02.3 MEASUREMENT

1. Removal and disposal of large rocks and boulders which exceed the requirements of sub-section 2.01.2 Clause 2 (page 2-1) shall be measured by cu.m of "Unclassified Highway Excavation" as prescribed in Section 2.03 - "Highway Excavation".

2. Unless shown as Pay Items in the Bills of Quantities, the Works (other than removal and disposal of large rocks and boulders) prescribed in this Section shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for Pay Items.

3. Where the Bills of Quantities contain a PROVISIONAL SUM for "Realignment or Replacement of Utilities by Owners", this sum will be used by the Employer to reimburse Utility Owners for approved realignment or

replacement Works carried out by such Owners or the Contractor and agreed with the Employer.

PAY ITEMS		UNIT OF MEASUREMENT
(1)	Realignment and Replacement of Utilities	PROVISIONAL SUM
(2)	Removal of Buildings, Fences, Pipes and Structures	LUMP SUM

ECTION 2.03: HIGHWAY EXCAVATION

.03.1 SCOPE

. These Works shall consist of excavating material in the cut sections of he highway, including watercourses, ditches and wadi relocations (but excluding orrow pits and structural excavation) all as and where shown on the Drawings, nd hauling the excavated material either to locations for highway embankments r to stockpiles or to waste.

. These Works shall also include any necessary excavations outside the OW ordered by the Engineer to safeguard and protect the Works. These may nclude diversion of existing wadi channels; excavation of materials obstructing r impairing the flow along stream channels; and excavation of unstable naterials including dune sand which may slide or encroach into ditches or onto he ROW. Disposal of all such excavated materials shall be as instructed by he Engineer.

. As part of the "Inspection of Site" obligations under Clause 11 of the eneral Conditions of Contract, the Contractor will be deemed to have atisfied himself, at the time of tendering, as to the type and nature of soils nd rock that will be encountered, and their location, suitability and sufficiency o meet the specified embankment and other requirements.

.03.2 CONSTRUCTION

Utilization of Excavated Materials

.1 All suitable soils, rock, boulders and other materials complying with ables 2.1 and 2.2 shall be excavated in such a manner that they can be tilised, if intended to be used, as embankment fill or in subgrade, shoulder or sewhere as appropriate.

TABLE 2.1

Soil Suitable for Embankment

1	-	Maximum dry density not less than 1.7 (T-180D)
2	-	Organic matter not more than 5% (T-267)
3	-	No use of A-6, A-7 soil (AASHTO M-145)
4	-	Maximum size not more than 2/3 of the layer thickness
5	-	No use of high to medium expansive soil
6	-	C.B.R. should not be less than 8% (AASHTO T-193)

TABLE 2.2

Rock Fill Suitable for Embankment

1	-	Size 25% larger than 30 cm
2	-	Size 50% larger than 7.5 cm
3	-	Bulk specific gravity not less than 2.25
4	-	Water absorption not more than 6%
5	-	Testing by a) plate bearing test b) surveying method
6	-	Filling material should not be A-6 , A-7 soil (AASHTO M-145)

1.2 If the Contractor chooses to excavate suitable material to waste or put it to other uses, and replace it by borrow excavation for embankment areas, this shall be undertaken at no extra cost to the Employer.

1.3 Materials such as existing concrete, bituminous or other surfaces or other materials shall, if shown on the Drawings, be stockpiled for a specific purpose or for future use. Such materials shall be excavated and handled in a manner that will exclude foreign or undesirable material. Stockpiles shall be neatly formed and maintained in an approved manner.

1.4 Suitable topsoil material if specified shall be stockpiled during excavation operations and shall subsequently be spread and compacted on embankment slopes and elsewhere as directed, to facilitate regrowth of vegetation.

2. Drainage of Excavation Areas

2.1 During construction, surfaces in excavation areas shall be adequately drained at all times. Side ditches or gutters emptying from cut to embankment shall be so constructed as to avoid damage to embankments by erosion.

2.2 The Contractor shall, at an early stage of the Works, provide adequate drainage by scheduling ditch and other construction so as to prevent saturation or erosion of embankments and cut slopes. All such drainage ditches and construction grades shall be cleaned and trimmed at regular intervals and when directed so that there will be an unobstructed runoff of stormwater during construction.

2.3 Damage to the Works attributable to saturation or erosion through failure to provide adequate drainage shall be repaired by the Contractor at his own expense.

2.4 Whenever groundwater is encountered which may adversely affect construction, the Contractor shall advise the Engineer who will evaluate the situation and order necessary remedial measures.

3. Obliteration of Disused Roadways

3.1 Obliteration of roadways which are no longer in use shall include filling of all ditches and rough grading of the old roadway to produce within the ROW a neat and well drained ground surface.

4. Rock Blasting

4.1 When blasting of rock slopes is carried out, a reasonably uniform face shall be left, regardless of whether or not the excavation is carried beyond the specified side slopes. All breakage and slides shall be removed by the Contractor and disposed of as directed.

4.2 Unless otherwise approved, all excavation of rock cuts higher than 4.5 m and requiring blasting for their excavation, shall be carried out in accordance with the requirements of Section 2.05 - "Presplitting Rock Cuts".

4.3 All drilling and blasting shall be done in such a manner as will most nearly complete the excavation to the required grade lines, and produce the least practicable disturbance of the material to be left in place. Blasting by means of drill holes, tunnels, or any other methods shall be entirely at the Contractor's risk. All requirements and obligations of Subsection 1.03.13 - "Use of Explosives" shall be strictly observed.

4.4 Where necessary or directed, the Contractor shall provide heavy mesh blasting mats for protection of persons, properties, and the Works. If, in the opinion of the Authorities and the Engineer, blasting would be dangerous to persons or adjacent structures, or is being carried out in an unsafe or unacceptable manner, the Engineer may prohibit blasting and order the rock to be excavated by other means.

4.5 If the flow of traffic is to be interrupted during blasting operations, the Contractor shall secure approval of his schedule for such interruptions and his proposed methods for safeguarding the public and property.

4.6 Excessive blasting will not be permitted. Overbreakage and the backfilling thereof shall be at the Contractors expense. Any material outside the approved cross section limits which may be shattered or loosened because of blasting shall be removed by the Contractor at his own expense. All rock slopes with loose material shall be scaled by workmen and all loose material removed.

4.7 Backfilling of overbreakage shall be carried out as directed, using approved soil or crushed materials or other special aggregate, as shown on the Drawings. Undrained pockets shall not be left in the surface of the rock.

5. Excavation of Unsuitable Material

5.1 Where excavation to finished grades and cross sections exposes unsuitable material in the subgrade, slopes or ditch inverts, etc the Engineer may require the Contractor to remove the unsuitable material and backfill the excavated areas using approved material. The Contractor shall conduct his operations in such a way that necessary cross section measurements are taken before such backfill is placed.

5.2 The Engineer may designate as unsuitable, soils that cannot be properly compacted in embankments. Unsuitable material shall be disposed of as directed. Wasted unsuitable material shall not be deposited on any cropland.

5.3 When the Contractor is directed to excavate unsuitable material below the surface of the original ground in fill areas, other than that required for clearing and grubbing, the depth to which unsuitable material shall be removed will be determined by the Engineer. The Contractor shall schedule the excavation so that cross sections are taken before and after material has been removed.

6. Slopes, Subgrade and Ditches

6.1 All excavated slopes, subgrade and ditches shall be finished true to lines, grades and cross sections as shown on the Drawings.

6.2 Slopes, except in solid rock or other material which require special treatment, shall be trimmed to slopes not steeper than the specified slope angles and rounded at top and bottom to a smooth profile to blend in with the adjacent terrain. Material shall not be loosened beyond the specified slope lines.

6.3 In cuts where earth overlays a rock formation, slopes shall be benched in an approved manner.

6.4 Ditches of all types shall be excavated and trimmed neatly in conformity with the specified grades and cross sections. All projecting rock, stumps, roots or similar shall be removed. Ditches include side ditches, furrow ditches, irrigation ditches, wadi relocations, etc.

6.5 Where the subgrade is composed of rock as defined in Section 2.07 - "Subgrade Construction and Topping", it shall be undercut to a depth of 200 mm below top of subgrade to allow for subsequent placing and compaction of the subgrade layer (topping).

6.6 The subgrade in cut, where the soil is unsuitable for retention as the subgrade layer, shall be subexcavated to a depth of 200 mm below top of subgrade to allow for subsequent placing and compaction of the subgrade layer (topping). If the material of the subgrade is suitable for retention as subgrade layer then scarify to the required depth, water and compact.

6.7 The Engineer will periodically check all or any part of the Works, to determine conformance to the correct lines, grades and elevations. Tolerances on finished subgrade elevations and on elevations of the surface at the underside of the subgrade layer, shall be as specified in Section 2.07 - "Subgrade Construction and Topping".

7. Unstable Materials Outside Right-of-Way

7.1 Materials, including sand dunes, outside the ROW or ditch slopes which, in the opinion of the Engineer, are potentially unstable and liable to slide or encroach into the ROW or into the ditches, shall be excavated and disposed of as specified for unsuitable material, unless it is approved for use as embankment fill.

8. Disposal of Unsuitable and Surplus Materials

8.1 Unsuitable and surplus materials disposed of elsewhere than within the ROW shall be spread, leveled and shaped as directed so as to present a neat and tidy appearance. No materials shall be disposed of in such a way as to

adversely affect natural drainage courses or to cause damage to the highway or adjacent public or private property.

8.2 If approved by the Employer, Government land can be used for disposal to the maximum extent practicable. If private land is used for disposal, the Contractor shall secure the consent of the landowner or tenant and, if necessary, and at his own expense, pay for the use of such land. The use of cropland for disposal purposes will not be permitted.

2.03.3 MEASUREMENT

1. All excavated material of whatever type (except for unauthorized rock undercut below top of subgrade) shall be measured as "unclassified" which shall be deemed to include all materials encountered of any nature, including silts, clays, sand, gravel and granular materials and fractured, jointed and solid rock, and unsuitable material.

2. Highway Excavation shall be measured by cu.m of material excavated, hauled away and either wasted, stockpiled, or deposited on or in vicinity of highway embankment areas, completed and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and the original ground elevations taken jointly by the Consultant and the contractor before clearing and grubbing operations.

3. Ditch Excavation shall be measured by lin.m of each type excavated and trimmed to required line, grade and cross section, including depositing excavated material along the side of ditch if directed or hauling away and wasting, stockpiling or depositing on or in the vicinity of highway embankment areas, completed and accepted.

4. Excavation of Unstable Material (from areas outside the ROW) shall be measured by cu.m of unstable or sand dune material excavated, hauled away and disposed of as directed, completed and accepted. Measurements shall be of volumes computed from surveyed cross sections of original and final ground elevations. When cross sectioning is impractical in the opinion of the Engineer, approval may be given to measure volumes in the vehicles removing such excavated material.

5. Rock blasting, backfilling of overbreakage, the trimming and grading of cut slopes, ditches and of other below-subgrade surfaces, drainage of excavation areas, obliteration of disused roadways, and other ancillary excavation Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for Pay Items.

PAY ITEM		UNIT OF MEASUREMENT
(1)	Unclassified Highway Excavation	Cubic meter (cu.m)
(2)	Unclassified Ditch Excavation (each type) except side ditches	Linear meter (lin.m)
(3)	Excavation of Unstable Material outside Right-of-Way	Cubic meter (cu.m)

SECTION 2.04: BORROW EXCAVATION

2.04.1 SCOPE

1. These Works shall consist of excavating suitable material from borrow pits, channels and designated borrow areas and hauling to locations for highway embankments or to stockpiles, all as and where shown on the Drawings, or as approved by the Engineer.

2. The Contractor shall be responsible for the location of suitable borrow pits if and when required, and for the suitability and sufficiency of borrow materials to meet the specified embankment and other backfilling requirements.

3. Borrow pits shall be utilized if there is insufficient suitable excavated material to satisfy the embankment and other backfilling requirements or if the Contractor chooses to excavate suitable material to waste or put it to other uses, and replace it by suitable material excavated from borrow pits.

2.04.2 LOCATION OF BORROW PITS

1. Borrow pits in the vicinity of the ROW shall have their location approved by the Engineer. Generally the borrow pits shall not be located within 50 m from the toe of embankment slope or top of cut or formed slope, unless otherwise approved by the Engineer . In water courses Borrow pits shall be only located Down stream .

2. In each case where a borrow pit is proposed within privately-owned property, the Contractor shall secure the consent of the landowner in writing and, if necessary and at his own expense, pay for the use of the material and land. The Contractor shall be responsible for any claims for compensation or complaints arising out of borrow pit operations and shall indemnify and keep idemnified the Employer against all such claims.

3. The side slopes of borrow pits or channels shall be constructed as shown on the Drawings or as directed. In no case shall the side slopes of borrow pits be steeper than 3:2 (H:V).

4. Details of the Contractor's proposed haul routes and traffic arrangements in relation to borrow pit operations shall be submitted for approval before any borrow excavation commences.

5. Overburden and any unsuitable top layers within each borrow pit shall be completely removed and stockpiled in the vicinity, ready for re-use prior to abandonment of the pit.

6. Prior to abandonment of any borrow pit or borrow area, the Contractor shall spread and level the original overburden over the exposed surfaces and clean up, grade and contour the pit or area and the adjoining properties occupied during execution of borrow operations, whether Government-, or privately-owned, all to the satisfaction of the Engineer.

2.04.3 BORROW MATERIAL

1. Borrow shall be material approved as meeting the requirements for the particular embankment, backfill or other use for which the material is intended.

2. The Contractor shall submit representative samples of materials from each of the proposed borrow pits or borrow areas. Testing shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing" and that listed on Table 2.3. No borrow material shall be used in the Works before its approval.

3. The Engineer will periodically require follow-up testing of borrow materials in accordance with Table 2.3 to verify that no change in quality has occurred since the original approval.

TABLE 2.3

Required Tests and Minimum Repetition for Earthworks at the Source of Materials

Description	Required Tests	Repetitions Required for all Tests
Embankment (at - 0.8 m from P.G.L and Downword)	1. Classification of Materials as per (AASHTO)	*One test for each borrow pit or suitable cut area for fill
	2. Any other tests as required in Special Specs. and Drawings	*When materials changed
	3. C.B.R.	
Subgrade and shoulders (upper three layers , Between -/ 0.2 m to - 0.8 from P.G.L and Downword)	1. Gradation of Materials	*One test for each borrow pit or suitable cut area for fill
	2. Plasticity Index	
	3. Any other tests as required in Special Specs. and Drawings	*Or for each 400 m^3
	4. C.B.R.	*When materials changed
Selected topping -0.2m from P.G.L	1. Gradation of Materials	*Test for each source
	2. Plasticity Index	*When materials changed
	3. Any other tests as required in Special Specs. and Drawings	
	4. C.B.R.	

2.04.4 MEASUREMENT

1. No measurements shall be made of any borrow pits or of any excavation from borrow pits.

SECTION 2.05: PRESPLITTING ROCK CUTS

2.05.1 SCOPE

1. These Works shall consist of presplitting rock cuts to produce a uniform plane of rupture so that the resulting backslope will be reasonably even with no overhang or protrusions, in close conformity to the lines and slopes shown on the Drawings and shall not be altered by subsequent blasting and excavation operations.

2. Presplitting involves the establishment of a free surface or shear plane by the controlled use of explosives and blasting accessories in appropriately aligned and spaced holes.

2.05.2 CONSTRUCTION

1. Faces of all cut slopes 1:2 (H:V) or steeper, exceeding 5 m in height and which require blasting to excavate, shall be formed by "presplitting" unless otherwise directed. Presplitting techniques for forming the faces of other formations, which could be excavated by means not requiring blasting, may be ordered by the Engineer.

2. Presplitting shall be by line drilling bore holes of 50 mm to 100 mm diameter at uniform intervals along the staked slope line. Except for required offsets, hole alignment shall be such that at no point does the hole deviate more than 300 mm from the staked slope line. Localized irregularities of surface variations that do not constitute a safety hazard or an impairment to drainage courses or facilities will be accepted.

3. Where the depth of cut to be presplit exceeds 10 m, the cut shall be drilled, blasted, and excavated in 2 or more lifts, unless otherwise approved by the Engineer. When 2 or more lifts of drilling are required, the staked slope line for the top lifts shall be set back from the slope line of the underlying lift a distance of 0.5 m to permit operation of drilling equipment for each succeeding line of drilled holes. Where benching is required, primary blasting holes shall not be drilled to an elevation lower than the presplit line holes.

4. The distance between the closest line of primary blasting holes and the line of presplit holes shall be determined during the blasting test. The distance and primary blasting charge shall allow for proper fragmentation but overbreakage behind the presplit line will not be permitted, and in no case shall the distance be less than one m.

5. Prior to starting drilling operations for presplitting, the Contractor shall submit a layout plan outlining the position of all drill holes, depth of drilling, type of explosives to be used, loading pattern, and sequence of firing. The drilling and blasting plan is for record purposes only and shall not absolve the Contractor of his responsibilities in respect of proper drilling and blasting procedures.

6. The Contractor shall drill, blast and excavate short test sections, not exceeding 30 m in length in each geological formation, to determine the controlled blast method, hole spacing, and charge best suited to the material encountered. The Contractor shall utilize a 0.75 m presplit hole spacing for the initial test section. In order to obtain the desired rock fracture, necessary adjustments shall be made and approval obtained before proceeding with full scale drilling and blasting operations.

7. Only standard cartridge explosives prepared and packaged by explosive manufacturing firms or other authorities shall be used in slope holes. These may consist of fractional portions of standard cartridges to be fixed to the detonating cord in the field or solid column explosives jointed and fixed to the detonating cord in the field. Ammonium nitrate, fuel oil type explosives shall not be used in the holes drilled for controlled blasting along the slope line.

8. A 15 m minimum horizontal length of finished presplit rock slope depth shall be produced prior to any primary blasting.

9. Prior to detonation of any charge, the Engineer shall be notified and kept informed of all activities and movements of traffic within and adjacent to the area where the Works are being performed.

10. The Engineer may order discontinuance of the presplitting operations when the rock formation is of such character that, in his opinion, no advantage is apparent.

11. Methods other than presplitting, which will assure cleanly sheared rock faces and control of overbreak, may be used only if approved. Such approval may be withdrawn by the Engineer at any time if subsequent results are found to be unsatisfactory.

2.05.3 MEASUREMENT

1. The Works prescribed in this Section shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for the Pay Items.

SECTION 2.06: EMBANKMENT CONSTRUCTION

2.06.1 SCOPE

1. These Works shall consist of constructing highway embankments, including preparation of the areas upon which they are to be placed; placing and compacting approved material within areas where unsuitable material has been removed; and placing and compacting approved embankment material in holes, pits and other depressions within the right-of-way area, all in accordance with the lines, grades and cross sections shown on the Drawings.

2.06.2 MATERIALS

1. Material specified in Table 2.1 or in the A-1, A-2-4, A-2-5 or A3 "when confined" groups as in AAHSTO M145 shall be used when available except for rock fill embankments, If material of this character is not available then materials from A-2-6, A-2-7, A-4, A-5, groups (AASHTO M145) or that specified under 'Special Specifications' may be used provided it complies with Table 2.1; however, special attention should be given to the design and construction. Materials classified as A6 or A7 shall not be used.

2. The 200 mm depth of embankment subgrade layer immediately below the bottom of sub base shall consist of selected topping material having a 4-day soaked CBR of at least 25% when tested in accordance with AASHTO T 193 and with a gradation and P.I. as specified under Section 2.07 - "Subgrade Construction and Topping".

3. The 600 mm depth of embankment immediately below the topping layer shall consist of material having a 4-day soaked CBR of at least 15% when tested in accordance with AASHTO T 193 with PI not more than 15, If not rock fill . If rock fill material is used for the bottom 400 mm then those requirment shall apply to the top 200 mm .

4. In areas subject to flooding and prolonged inundation of the embankment, such as at bridge and culvert sites, the material used in embankment, unless rock, shall conform to AASHTO M 145, Class A-1-a, A-1-b, A-2-4.

5. Where embankments are to be constructed using fine wadi materials or sand dune materials subject to side slope erosion or requiring confinement for stabilization purposes, the embankment plating or confining layer shall be constructed using AASHTO M 145 Class A-1-a, A-1-b, or A-2-4 materials or as otherwise approved.

6. The material used in rockfill embankments shall consist predominantly of rock fragments of such size that the material can be placed in layers of the thickness prescribed conforming to requirements stated on Table 2.2.

7. Rockfill material shall be obtained from roadway or tunnel excavation and shall be sound, dense, hard and durable rock capable of being spread and compacted as specified. Individual pieces are to be clean and angular. It shall be the contractor's responsibility to excavate material from rock cuts, whether by blasting or other manner, so that all excavated materials are of suitable size.

8. When suitable materials of widely divergent characteristics are drawn from different sources, such materials may, if approved, be mixed to meet the embankment requirements. Rock and other materials shall be incorporated in such manner as to avoid segregation and an accumulation of boulders, etc at the toe of embankment slopes.

9. Logs, trees, stumps, weeds, heavy grass, frozen soil, vegetable matter or other undesirable and noncompactible materials shall not be placed in embankments.

10. Rocks, broken concrete or other solid materials larger than 100 mm in any dimension shall not be used as backfill in areas where piling Works are to be carried out.

2.06.3 CONSTRUCTION

1. General

1.1 Prior to placing embankment material on any area, it shall have been cleared and grubbed as specified in Section 2.01 - "Clearing and Grubbing", and the foundation prepared as specified herein.

1.2 Equipment used for foundation preparation and for placing, spreading and compacting embankment materials shall be of approved types and furnished in sufficient numbers for the purposes intended. Provision and use of such equipment shall conform with the relevant requirements of Section 1.12 - "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

1.3 Draglines shall not be used to construct embankment unless approval is given and only when special procedures are adopted to keep the layers uniform and the embankment properly graded and well-drained at all times.

1.4 Surfaces of embankment layers shall be kept properly shaped and drained at all times. The Contractor shall utilize a sufficient number of motor graders or tractors to level and maintain the surface of each layer of embankment during all placing and compacting operations.

1.5 Rockfill shall not be used in the top 20 cm of the embankment (below the topping). Water must be added as required, and with the approval of the Engineer, to achieve maximum compaction.

1.6 Whenever feasible, trucks, scrapers, tractors and other heavy hauling equipment shall be routed over the embankment in such a manner as will contribute effectively to compaction of the fill material.

1.7 Where an embankment is to be constructed over an area previously occupied by a building basement, cellar, irrigation canal, well, any previous excavation, or adjacent to structures, and where the proper use of normal compaction equipment is not practicable, the embankment shall be constructed and compacted in accordance with the backfilling requirements of Section 2.09 - "Excavation and Backfill for Structures" until the use of normal compaction equipment is practicable. Layers shall not exceed 200 mm thickness (after compaction) and shall be compacted to the degree of compaction specified for the embankment.

1.8 Each embankment layer shall be tested and approved prior to placing the following layer. At least one field density test shall be carried out for every 1500 square meters of each compacted layer.

1.9 The Engineer may at any time order suspension of delivery of materials to the embankment Sites until previously delivered materials have been properly placed and preceding layers are leveled and uniformly compacted to the specified density.

1.10 Unacceptable material placed in any embankment shall be removed and disposed of by the Contractor at his own expense.

1.11 The Contractor shall be responsible for the stability of all embankments and shall replace all embankment sections which, in the opinion of the Engineer, have been damaged or displaced due to carelessness or neglect on the part of the Contractor, or due to normally occurring natural causes, such as storms, and not attributable to the unavoidable movement of the natural ground upon which the embankment is constructed.

1.12 All embankment side slopes shall be neatly finished true to the lines and not steeper than the slope angles as shown on the Drawings. The bottom (toe) of side slopes shall be graded to a well rounded, smooth profile to blend in with the adjacent terrain.

1.13 The side slopes of rockfill embankments shall be thoroughly blanketted with A-1, A-2-4 material, and compacted to the satesfaction of the engineer .

1.14 The Engineer may permit the Contractor to utilize suitable surplus material at his own expense to widen embankments or flatten slopes, etc within the right-of-way. Surplus material used in such manner shall be compacted to 90 per cent of maximum density, but this shall not be measured for payment. When widening embankments, the Contractor shall bear the cost of modifying the culverts and any protection work necessary.

2. **Trial Embankment Sections**

2.1 Prior to commencement of embankment construction, the Contractor shall construct trial sections of embankment, for each significant soil category (excluding rock) to be encountered along the line of the highway. Each trial section shall be 2 lanes wide by 100 m long at approved locations on or adjacent to the Site.

2.2 Compaction and other equipment used shall be as specified and listed in the Contractor's Equipment Schedule and approved Program of Work. These trials shall be used to determine the suitability of materials, the most suitable field moisture content of the different soils and the relationship between the number of compaction equipment passes and density attained.

2.3 The initial sections of highway rock embankment shall serve as the trial sections for rock fill, in order to establish the optimum degrees of consolidation for the different layer thickness. This shall be obtained by compaction trials correlating number of pases of the roller with settlement of the layer, or by different approved methods. The maximum permitted layer thickness shall be related to the unit weight of the vibratory roller and for compaction, as given in Table 2.4, and shall not exceed 100 cm loose thickness.

TABLE 2.4

Maximum Thickness of Layer (Loose Thickness)	Minimum Roller Mass* (Kg/m Width)
40cm	2300 - 2900
60cm	2900 - 3600
80cm	3600 - 4300
over 100cm	4300 - 5000

* For multiple rollers, this shall be assumed as the high axle load.

3. Foundation Preparation

3.1 If the original surface upon which embankment is to be placed is an existing roadbed, the surface shall be plowed, scarified, or otherwise broken up regardless of the height of the embankment to be placed thereon.

3.2 Clearing and grubbing, and removal of tree stumps, shall be undertaken. The degree of compaction for the area to be cleared shall then be determined. The top 150mm of the surface on which the embankment, of less than 1.5m height is to be placed shall be scarified, brought to a uniform moisture content within the specified range, and compacted to the density specified for the embankment.

3.3 Where embankment is to be placed and compacted on hillsides or where new embankment is to be compacted against existing embankments or where embankment is built part width at a time, the slopes steeper than 3:1 (H:V) when measured at right angles to the highway centerline shall be continuously benched as the embankment is brought up in layers. Benching shall be of sufficient width to permit operation of spreading and compaction equipment, and in any case not less than 2 m wide except where insufficient width is available between existing and new embankments. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. The vertical face of each bench shall not be less than 1 m in height and not exceed 2 m. Authorized benching shall be measured as highway excavation.

3.4 Where embankment is to be placed and compacted on wadi slopes, the entire slope area shall be graded and trimmed to remove any vertical faces and overhangs. The final graded slope shall not be steeper than 1.5:1 (H:V). The slope shall then be continuously benched as the embankment is brought up in layers, all as described above for embankment on hillsides.

3.5 All surfaces to receive rockfill are to be cleared and all vegetation removed off site before filling is placed. All unsuitable soil shall be removed to a depth as required by the Engineer. Soil surfaces are to be scarified and recompacted to at least 95% of the maximum dry density as modified AASHTO (T-180). Compaction is to be to a depth of at least 200 mm below ground surface. Hard or smooth surfaces are to be roughened before filling is placed. Existing road surfaces and the like are to be broken up and removed.

3.6 Rockfill shall not be placed on any slopes steeper than 1:1. All slopes steeper than 1:1 shall therefore be regraded to a slope of 1:1 or shallower and all vertical faces and overhangs removed.

4. Embankment Construction

4.1 Roadway embankment consisting of soil or granular material shall be placed in horizontal layers not exceeding 250 mm thickness (before compaction), shall be compacted as specified and shall be approved prior to placing the next layer. The thickness of the first layer over areas of Class A-3 dune sand may exceed 250 mm in order to bridge these areas. Approximately uniform thickness of each layer shall be achieved prior to compaction. As the compaction of each layer progresses, continuous leveling and working of the material shall be carried out to ensure uniform density. The correct moisture content shall be maintained at all times.

4.2 Where embankments are to be constructed to a height in excess of 1.5 m above top of original ground level the Engineer may approve layer thickness up to 300 mm (after compaction) if the Contractor's equipment and the nature of the material result in the required density throughout the layer thickness.

4.3 When the moisture content of the embankment material does not fall within the required moisture range, (optimum moisture 2%) water shall be added and thoroughly mixed into the soil by approved methods or the material shall be aerated, whichever is necessary to adjust the material to the required moisture content.

4.4 When water is added to embankment material, the amount added shall be sufficient to provide a moisture content within the required range plus a reasonable additional amount to compensate for evaporation and other unavoidable losses. Water added in excess of this amount shall be removed by aeration or other approved means at the Contractor's expense. Satisfactory methods and sufficient equipment shall be used for the furnishing and handling of the water in a manner that will minimize loss due to evaporation or waste.

4.5 Embankments that consist of rock-soil material with sufficient soil to make rolling feasible, shall be placed and compacted in an approved manner and to the required degree of consolidation. Water shall be added as and when directed to assist in the compaction of such materials.

4.6 In the case of embankments which are to be formed of approved rock-soil material containing an appreciable quantity (normally not exceeding 30% greater than 80mm) of rock fragments and which cannot be placed in layers of the thickness prescribed without crushing, pulverizing, or otherwise breaking down the fragments, the embankment may be constructed in layers not exceeding in thickness twice the average size of the largest rock fragments and in any case not exceeding 600 mm (before compaction).

4.7 Rockfill materials shall be placed in such a manner that the larger rocks are well distributed and the voids are filled to the maximum practical extent by smaller particles, each layer shall be bladed into a neat and homogeneous mass prior to compaction. Any rocks found protruding from the leveled surface shall be removed and replaced by smaller particles. Initial breakdown compaction shall be performed with heavy bulldozers. After compaction each layer must be tested, using either the Survey Test or the Plate Bearing test, and approved by the Engineer before the next layer is placed. survey test shall be carried out for each layer while plate bearing test shall be carried out for every second layer . The top two layes shall be tested by both methods . If plate bearing test result shows successive satesfaction result then the engineer could reduce the number of repetitions of such tests. Oversize rock pieces may be used in high rockfill embankments to a level 3 metres below sub-base. When rock fragments of size exceeding 600mm are used, they should be covered.

2.06.4 TESTING

1. General

1.1 The Engineer shall test the compaction of soils and the consolidation of rock and rock-soil materials in accordance with these Specifications to ensure that adequate compaction or consolidation has been achieved. All such tests shall be fully documented by the Contractor, in an approved manner.

1.2 In the case of cohesionless, free draining rock-soil materials, where maximum density tests fail to produce a well defined moisture - density relationship, the relative density test shall be used, alternatively an electronic compaction meter or any other approved test equipment shall be provided by the Contractor and used to determine the degree of consolidation achieved.

1.3 To determine the degree of consolidation for embankment consisting of rock fill, average differential settlement values shall also be determined from surveys of an adequate number of grid point elevations as and when directed, at the commencement of, during and after embankment construction. For full details of the method (The Survey Test) refer to clause 3, page 2-28. Degree of consolidation for rock materials.

1.4 If it is required to determine the modulus of soil reaction by the Plate Bearing test, this shall be undertaken using the method given in AASHTO T222-81 (1986).

2. Standards of Compaction for Soil and Granular Materials

2.1 The following compaction standards shall apply to embankment materials other than predominantly rock materials. The "maximum density" of soil type materials shall be the modified maximum density determined in accordance with AASHTO T 180 (Method D). The "relative density" shall be the relative density

determined in accordance with ASTM D4254, which identifies the state of compactness of the material with respect to its loosest and densest state. The relative density shall be the standard to which the field density is referred for comparison in the case of cohesionless, free draining granular materials.

2.2 Soil type materials shall be compacted to at least 95% modified maximum density for the full depth of embankment. The 600 mm of embankment material immediately below the topping layer shall be compacted to at least 100% modified maximum density. Moisture content shall be within plus or minus 2% of optimum at the time of compaction.

2.3 Cohesionless, free draining granular materials (of 75 mm maximum size and with not more than 15% passing 0.075 mm (No. 200) sieve) shall be compacted to at least 75% of relative density for the full depth of embankment. The 600 mm depth of such material immediately below the topping layer shall be compacted to at least 80% of relative density.

2.4 Minimum in-situ soil tests required during the construction of embankment are listed on Table 2.5.

2.5 All suitable surplus material utilized to widen embankments or flatten slopes, etc within the right-of-way shall be compacted to at least 90% modified maximum density.

3. Degree of Consolidation for Rock Materials

3.1 To ensure proper compaction of rockfill embankments, the contractor shall be required to conduct compaction tests using equipment and materials available in order to determine the best compaction control criteria.

3.2 A rockfill test section shall be placed on a firm surface approved by the Engineer, and the material and layer thickness shall conform to the requirements of these Specifications.

3.3 The test section shall be of sufficient dimensions to permit the establishment of at least twenty leveling points on a 5 meter (5m) square grid, and no fewer than 3 points on any one line and no point less than three meters from the edge of the layer. The arrangement of the levelling points shall be approved by the Engineer.

3.4 Compaction shall then commence with a minimum of three passes of a vibratory roller. Leveling points are then established. Short lengths of painted steel bars hammered flush with the surface of the rockfill have been found suitable for this purpose. A level reading is taken at each leveling point

on top of a moveable 30 cm square flat steel plate. A hole drilled in the center of the plate will enable a visual check to be made that the plate is located centrally over the bar each time.

3.5 Further readings are taken at the leveling points after two additional passes with the roller. If the average settlement is less than half of one per cent (0.5%) of the average compacted layer thickness, or as determined by the Engineer, the rockfill compaction test is complete.

3.6 If the average settlement is more than half of one percent (0.5%), two additional passes of the roller are required and the leveling procedure repeated. If the average settlement is now less than half of one percent (0.5%), the test is complete. If not, this step is then repeated.

3.7 The total number of passes of the rolling equipment necessary to obtain the required result will establish the minimum number of passes to be used on the rock embankments. The contractor shall then use this simplified procedure, that is, the equipment, rolling pattern, and number of passes, during the construction of rock embankments. However, in no case shall the number of passes be less than five (5).

3.8 This verification procedure shall be conducted for each change of material and at least once each week during the initial stages of construction until a reliable rolling pattern is established. The frequency can then be reduced as approved by the Engineer.

TABLE 2.5

Required Tests and Minimum Repetitions for Earthworks during Embankment Construction

Control on Site (The Road)	
Required Tests	**Repetitions Required**
1. Maximum dry density (Proctor)	*One test for every 1000 l.m. for each layer
2. Soil Classification as per (AASHTO)	
3. Any other tests as required per Special Specs. and Drawings	*When materials changed
4. Field Density	*For every 1500 m^2 for each layer

3.9 Documentation of the rockfill compaction tests shall be maintained in the project records.

4. Monitoring Settlement of Rockfill

4.1 On completion of the embankment, the contractor shall carry out precise leveling of the crest of the embankment. This shall consist of leveling transverse sections (a minimum of five points) at a maximum spacing of 30 m along the embankment. These shall be referenced to a stable approved datum. Leveling shall be carried out at suitable time intervals until the average rate of settlement over a period of one month does not exceed 0.05 mm per day. No permanent pavement construction will be permitted until the specified criteria is achieved.

2.06.5 MEASUREMENT

1. All embankment, of whatever type, shall be measured as "unclassified" which shall be deemed to include all materials of any nature, including silts, clays, sand, gravel and granular materials and fractured, jointed and solid rock.

2. Embankment Construction shall be measured by cu.m of approved unclassified material placed, spread, watered as necessary, compacted and finished, and accepted. Measurements shall be of volumes computed from cross sections shown on the Drawings and the original ground elevations, less the volume of subgrade layer (topping) which shall be measured separately as prescribed in Section 2.07 - "Subgrade Construction and Topping".

3. The volume of embankment displaced by pipe culverts, box culverts and associated end walls, bridge piers and abutments, shall be deducted from the measured volume of embankment. No deduction shall be made for pipes less than 500 mm in diameter and associated end walls.

4. Surplus materials utilized at the Contractor's option within the ROW but, beyond the cross sections shown on the Drawings, shall not be measured for payment.

5. Replacement of Unsuitable Material (the excavation and disposal of which are measured under "Highway Excavation") shall be measured by cubic meter of approved unclassified material furnished from approved sources, placed, spread, watered as necessary, compacted, finished as directed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and the depths of excavation of unsuitable material ordered by the Engineer, and paid for under item for Embankment.

6. No adjustments or allowances of any kind shall be made in respect of expansion or shrinkage of earthwork volumes which may occur during excavation and compaction Works.

7. Scarifying old roadbeds, construction of the trial embankment section if it is outside the road and foundation preparation, testing including furnishing and using an approved type electronic compaction meter and grid pattern consolidation surveys, and other ancillary embankment Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

PAY ITEM	UNIT OF MEASUREMENT
(1) Embankment Construction	Cubic Meter (cu.m)

SECTION 2.07: SUBGRADE CONSTRUCTION AND TOPPING

2.07.1 SCOPE

1. These Works shall consist of furnishing materials, constructing the subgrade layer and preparing the subgrade surface (top of subgrade , P.G.L) ready to receive the pavement structure and shoulders, all as and when shown on the Drawings.

2. The subgrade layer is the 200 mm minimum depth of selected material (topping) immediately below the subgrade surface (top of subgrade , P.G.L).

3. Construction using cement, bitumen or lime stabilized material for the subgrade layer, shall be as specified in Section 2.08 - "Stabilized Subgrade Construction".

2.07.2 MATERIALS

1. Topping shall consist of selected borrow material having a 4-day soaked CBR of not less than 25% when tested in accordance with AASHTO T 193 when compacted at 100% of modified proctor AASHTO (T-180-D) and having a maximum P.I. of 12%. Topping gradation shall be reasonably smooth without gap grading. All topping material shall pass 75 mm sieve and not more than 18% shall pass 0.075 mm (No. 200) sieve.

2. In situ material shall be deemed to be rock if it is natural solid mineral matter occurring in large masses; if it is non-ripable by D8 or equivalent; and if 100 mm diameter core specimens, when tested in accordance with ASTM D2938, have a crushing strength of at least 7 MN/sq.m (70 kg/sq.cm) when dry and at least 4 MN/sq.m (40 kg/sq.cm) when tested after soaking in water for 24 hours.

3. Minimum tests required on subgrade are listed on Table 2.6.

TABLE 2.6

Required Tests and Minimum Repetitions for Earthworks for Sub-grade and Topping

Description	Required Tests	Repetitions required for all Tests
Top 60 cm of embankment belw sub-grade layer	1. Proctor	*One test for every 1000 l.m. for each
	2. Gradation of materials	*When materials changed
	3. Plasticity Index	
	4. Classification of materials as per AASHTO	
	5. C.B.R.	
	6. Any other tests as required in Special Specs. and Drawings	
	7. Field Density	*Test for every 1500m^2 or 100 l.m for each layer
Sub-grade layer (selected topping) each	1. Proctor	*One test for every 500 l.m. for layer
	2. Gradation of materials	*When materials changed
	3. Plasticity Index	
	4. C.B.R.	
	5. Any other tests as required in Special Specs. and Drawings	
	6. Field Density	*One test for every 1500 m^2 or 100 l.m. for eash layer
	7. Thickness of layer	

2.07.3 CONSTRUCTION

1. Subgrade in Cut

1.1 Where the subgrade is located in rock, the subgrade, unless shown otherwise on the Drawings, shall be undercut to a depth of 200 mm by drilling or blasting as directed. No rock shall project more than 50 mm above the undercut surface elevation. The subgrade layer shall then be constructed using approved topping material, as specified for subgrade in embankment.

1.2 Where the subgrade is on in situ soil which is of a quality and CBR value at least equal to those specified for topping, the 200 mm depth of such material immediately below top of subgrade shall be scarified and all roots, sod, vegetable and other undesirable matter and stones larger than 75 mm in any dimension shall be removed. The material shall then be brought to a uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.

1.3 Where the subgrade is on in situ soil which is unsuitable for retention as the subgrade layer, the 200 mm depth of such material immediately below the top of subgrade layer shall be subexcavated, hauled away and disposed of. The subgrade layer shall then be constructed using approved topping material, as specified for subgrade in embankment . If the material below sub-grade does not satisfy the requirment of top 60 cm . It shall be excavated for further 20 cm and replaced by suitable material to satisfy the requirments of section 2.06.2-3.

2. Subgrade in Embankment

2.1 The 200 mm minimum depth of embankment immediately below top of subgrade shall consist of selected, approved topping material. The topping shall be spread in one layer over the full width of the top of embankment, brought to a uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.

3. Surface Tolerances

3.1 All finished elevations, lines and grades shall be in accordance with the details shown on the Drawings. Each cross section shall be checked at maximum intervals of 25 m, at each change in cross slope and elsewhere as directed.

3.2 The tolerances on elevations of finished subgrade, top of embankment under the subgrade layer and subexcavated (undercut) surface shall be as follows:

Surface	Tolerances
Finished Subgrade:	
Soil	+10 or -30 mm
Rock (if approved)	+50 or -50 mm
Top of Embankment or Subexcavated Surface:	
Soil	+10 or -30 mm

3.3 When the finished subgrade surface is tested with a 4 m long straightedge placed parallel to, or at right angles to the centerline, the maximum depression of the surface from the testing by straight edge shall be 30 mm.

4. Maintenance of Finished Subgrade

4.1 The finished and approved subgrade shall be continuously maintained in a smooth, well compacted and properly drained condition until the sub-base (or base) course is constructed. Reapproval of the subgrade will be required if the overlying course is not constructed within 14 days of subgrade completion or if the subgrade layer is damaged by traffic or any other causes prior to the placement of the sub-base layer.

2.07.4 MEASUREMENT

1. Subgrade layer or layers in undercut rock, in subexcavated soil and in embankment, shall be measured by cu.m of approved topping material furnished, spread, compacted, completed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings.

2. Subgrade layer or layers in approved in situ material shall be measured by sq.m of subgrade layer scarified to a minimum depth of 200 mm including removal of undesirable matter, compacted, completed, and accepted. Measurements shall be of areas computed from cross sections shown on the Drawings.

3. Subexcavation of soil material and undercutting of rock below top of subgrade shall be measured as unclassified excavation, as prescribed in Section 2.03 - "Highway Excavation".

4. No adjustments or allowances of any kind shall be made in respect of expansion or shrinkage of earthwork volumes which may occur during excavation and compaction Works.

5. Maintenance and drainage of finished subgrade, retesting for reapproval, disposal of surplus materials and other ancillary subgrade Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

PAY ITEM	METHOD OF MEASUREMENT
(1) Subgrade Layers (topping)	Cubic meter (cu.m)
(2) Subgrade Layers (in situ material)	Square meter (sq.m)

SECTION 2.08: STABILIZED SUBGRADE CONSTRUCTION

2.08.1 SCOPE

1. These Works shall consist of furnishing mixing, spreading, compacting and finishing the subgrade layer, composed of sand, sandy gravel, sandy clay soil or similar materials, stabilized with cement or bitumen or lime as appropriate, as and where shown on the Drawings.

2.08.2 MATERIALS

1. Cement, bitumen and lime for use as stabilizing agents shall conform with the relevant requirements of Section 3.01 - "Materials". Unless shown on the Drawings the Engineer will determine the type of cement to be used or the type and grade of bitumen to be used, or whether hydrated lime or quicklime shall be used.

2. The material to be stabilized shall conform with the gradation and other requirements specified for the particular stabilizing agent to be used.

3. Curing seal shall consist of an approved proprietary curing compound, or MC-70 cutback bitumen to Prime Coat standard as specified in Section 4.01 - "Materials" and Section 4.02 - "Bituminous Prime and Tack Coats".

4. Water shall be potable and shall conform with the relevant requirements of Section 5.01 - "Concrete and Concrete Mixes and Testing".

2.08.3 CONSTRUCTION OF TRIAL SECTIONS

1. At least 10 days before commencement of Site stabilization Works and after completion of laboratory mix design, the Contractor shall lay trial sections for each type of subgrade stabilization intended to be constructed. Each trial section shall be 2 lanes wide by 100 m long, at approved locations on or close to the Site. Each trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures, proposed for use in the Works.

2. Each trial section shall serve as a field verification of the laboratory mix design. The results of the dry density and moisture content measurements made in the trial section will be used in association with the laboratory tests to establish the required moisture content and minimum compaction effort to be attained in the Site stabilization Works.

3. Each trial section shall also demonstrate the adequacy of mixing, spreading and compaction equipment and the suitability of the methods and organization proposed.

2.08.4 CONSTRUCTION GENERALLY

1. Construction of stabilized subgrade layers in cut and in embankment, and the maintenance of finished subgrade, shall conform generally with the relevant requirements of Section 2.07 - "Subgrade Construction and Topping" and with the requirements specified herein for each type of stabilization to be executed as part of the Works.

2.08.5 CEMENT STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized shall, unless otherwise approved, be a naturally occurring silty or clayey soil with a P.I. not exceeding 20% and L.L. not exceeding 45%. If the pH value of soil is less than 12.0, up to 2% calcium chloride (based on laboratory testing) may be added to increase the alkalinity. The soil shall contain not more than 4% sulphates and not more than 8% chlorides.

1.2 The cement content and optimum moisture content for the soil-cement mix shall be determined as specified in Section 3.04 - "Stabilized Courses". The minimum compressive strength at 7 days after molding shall be 4 MN/sq.m (40 kg/sq.cm) and the cement content of trial mixes shall be adjusted until this strength is achieved.

1.3 The maximum volume change (swelling) shall be 2% and the maximum loss in weight shall be 7%, when cylinders are molded and tested in accordance with AASHTO T 135, Method B.

1.4 Cement content and water content of the mix on the Site shall each be within -0% to +2% of the approved mix design.

2. Mixing, Placing, Compacting and Finishing

2.1 Mixed in place procedures will normally apply in the case of subgrade stabilization when the soil to be stabilised is a naturally occurring, in situ material.

2.2 Equipment used for scarifying and pulverizing the in situ soil, mixing the soil and cement and compacting and finishing the soil-cement subgrade layer, shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.3 Plant for batch mixing or continuous mixing of soil and cement shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.4 Where batch mixing or continuous mixing is approved, the equipment used for transporting, placing, spreading, compacting and finishing the soil-cement mix shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.5 Procedures for making good any areas lower than the allowable tolerances and the application of a curing seal to the completed surface shall be as specified in Section 3.04 - "Stabilized Courses".

2.08.6 TESTING OF CEMENT STABILIZED SUBGRADE

1. Sampling and testing shall be as specified in Section 3.04 - "Stabilized Courses", except as follows:

1.1 Cement content in accordance with AASHTO T 144

1.2 Gradation of mix in accordance with AASHTO T 88

2.08.7 BITUMEN STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized shall, unless otherwise approved, be a naturally occurring sand, or silty or clayey gravel, with a P.I. not exceeding 15% and L.L. not exceeding 35% and with not more than 35% passing 0.075 mm (No. 200) sieve.

1.2 The optimum bitumen content for the soil-bitumen mix shall be determined as specified in Section 3.04 - "Stabilized Courses".

1.3 The minimum compressive strength of cylinders at 7 days after molding and at 25 degrees C, shall be 2 MN/sq.m (20 kg/sq.cm) and the Marshall stability shall be 2,000 N (204 kg).

1.4 The Index of Retained Strength when tested in accordance with AASHTO T 165 shall not be less than 70%.

2. Mixing, Placing, Compacting and Finishing

2.1 Mixed in place procedures will normally apply in the case of subgrade stabilization when the soil to be stabilized is a naturally occurring in situ material.

2.2 Equipment used for scarifying and pulverizing the in situ soil, applying the bitumen and mixing the soil and bitumen, and compacting and finishing the soil-bitumen subgrade layer, shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.3 Plant for batch mixing or continuous mixing of soil and bitumen shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.4 When batch mixing or continuous mixing is approved, the equipment used for transporting, placing, spreading, compacting and finishing the soil-bitumen mix shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

2.5 Procedures for making good any areas lower than the allowable tolerance and the application of a curing seal to the completed surface shall be as specified in Section 3.04 - "Stabilized Courses".

2.08.8 TESTING OF BITUMEN STABILIZED SUBGRADE

1. Sampling and testing shall be as specified in Section 3.04 - "Stabilized Courses".

2.08.9 LIME STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized shall, unless otherwise approved, be a naturally occurring clayey gravel, clayey sand or lean clay soil with not more than 50% passing 0.425 mm (No. 40) sieve. The soil shall be of a standard acceptable for use in embankments.

1.2 The lime content and optimum moisture content for the soil-lime mix shall be determined as specified in Section 3.04 - "Stabilized Courses".

1.3 The minimum cylinder compressive strength at 7 days after molding shall be 1 MN/sq.m (10 kg/sq.cm).

1.4 Lime content and water content of the mix on Site shall each be within -0% to +2% of the approved mix design percentages.

2. **Safety Precautions**

2.1 Safety precautions when handling quicklime or hydrated lime shall be observed, as specified in Section 3.04 - "Stabilized Courses".

3. **Mixing, Placing, Compacting and Finishing**

3.1 Mixed in place procedures will normally apply in the case of subgrade stabilization when the soil to be stabilized is a naturally occurring, in situ material.

3.2 Equipment used for scarifying and pulverizing the in situ soil, mixing the soil and lime (either dry or as a slurry), and compacting and finishing the soil-lime subgrade layer, shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

3.3 Plant for batch mixing or continuous mixing of soil and lime shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

3.4 Where batch mixing or continuous mixing is approved, the equipment used for transporting, placing, spreading, compacting and finishing the soil-lime subgrade layer shall be of approved types and shall be operated all as specified in Section 3.04 - "Stabilized Courses".

3.5 Procedures for making good any areas lower than the allowable tolerances and the application of a curing seal to the completed surface shall be as specified in Section 3.04 - "Stabilized Courses".

2.08.10 TESTING OF LIME STABILIZED SUBGRADE

1. Sampling and testing shall be as specified in Section 3.04 - "Stabilized Courses".

2.08.11 SURFACE TOLERANCES

1. All slopes, lines and grades shall be in accordance with the details shown on the Drawings. Each cross section shall be checked at maximum intervals of 25 m, at each change in cross slope and elsewhere as directed.

2. The smoothness of finished subgrade surfaces and the tolerances on elevations of subexcavated (undercut) surfaces and on finished subgrade surfaces

shall conform with the requirements specified in Section 2.07 - "Subgrade Construction and Topping".

2.08.12 MEASUREMENT

1. Stabilized Subgrade Layer in undercut rock, in subexcavated soil and in embankment, shall be measured by cu.m of each type of stabilized material furnished, spread, compacted, completed, and accepted. Measurements shall be of volumes computed from the cross section shown on the Drawings.

2. Stabilized Subgrade Layer incorporating naturally occurring in situ soil shall be measured by the cu.m of subgrade layer scarified, pulverized, mixed with stabilizing agent of each type, compacted, completed, and accepted. Measurements shall be of volumes computed from cross sections shown on the Drawings.

3. Measurements shall also be made of the Trial Section or Sections in accordance with the length, width and thickness of each completed Section ordered by the Engineer, if it is outside the road.

4. Subexcavation of soil material and undercutting of rock below top of subgrade shall be measured as unclassified excavation, as prescribed under Section 2.03 - "Highway Excavation".

5. No adjustments or allowances of any kind shall be made in respect of expansion or shrinkage of earthwork volumes which may occur during excavation and compaction Works.

6. Maintenance and drainage of finished subgrade, retesting for reapproval if necessary, disposal of surplus materials and other ancillary subgrade Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

PAY ITEM	UNIT OF MEASUREMENT
(1) Cement Stabilized Subgrade Layer:	
Imported Soil	Cubic meter (cu.m)
In Situ Soil	Cubic meter (cu.m)
(2) Bitumen Stabilized Subgrade Layer:	
Imported Soil	Cubic meter (cu.m)
In Situ Soil	Cubic meter (cu.m)

(3) Lime Stabilized Subgrade Layer:

Imported Soil — Cubic meter (cu.m)

In Situ Soil — Cubic meter (cu.m)

SECTION 2.09: EXCAVATION AND STRACTURAL BACKFILL

2.09.1 SCOPE

1. These Works shall consist of all excavation in any material for bridges, underpasses and overpasses; for buildings and pumphouses; for culverts, storm drains, utility ducts and underdrains; for drainage and utility structures; for retaining walls of all types; and for other major and minor structures; and including all necessary clearing and grubbing; bailing; drainage; pumping; sheeting; temporary shoring and cribbing; construction of temporary cofferdams or cribs; and disposal of all excavated material and backfilling with suitable approved material; all as and where shown on the Drawings.

2. These Works shall also include the removal of those portions of existing structures below ground which would in any way obstruct or interfere with construction of new structures.

3. As part of the "Inspection of Site" obligations under Clause 11 of the General Conditions of Contract, the Contractor will be deemed to have satisfied himself, at the time of tendering, as to the type and nature of soils and rock that will be encountered in structural excavations.

2.09.2 EXCAVATION

1. General

1.1 The Contractor shall notify the Engineer a sufficient time in advance of the beginning of any excavation for structures so that the Engineer may, where necessary, survey and record the cross sectional elevations and measurements of the existing ground and existing structures affected by the proposed structure. Any materials removed or excavated before these measurements have been taken and approved by the Engineer will not be paid for.

1.2 The Contractor shall be solely responsible for the safety at all times of all foundation and trench excavations whether supported or otherwise. Approval of the Contractor's support system or omission of a support system for any excavations shall not absolve the Contractor from his sole responsibility in this regard.

1.3 The sides of all foundation pits and trenches shall be vertical unless otherwise shown on the Drawings and the walls shall be adequately supported at all times. Walls more than 1.5 m in depth shall be sloped at a safe slope or supported in an approved manner unless the material through which the pit or trench is cut is deemed to be sufficiently self supporting and not requiring external support.

1.4 The Contractor shall take necessary precautions, including shoring or otherwise, to protect employees in the excavation and on the ground above. The Engineer will not enter excavated areas to approve the foundation and further Works until he deems the areas to be safe.

1.5 In areas where the excavation is adjacent to public roads and walkways, the Contractor shall erect all necessary barricades, barriers, enclosed walkways, and warning signs necessary to restrict the exposure of the public to the excavation. All such safety measures shall conform with the requirements of Section 8.10 - "Maintenance of Traffic and Detours" and shall be subject to approval.

1.6 Pits and trenches shall be kept free from water until footing concrete has been placed or pipes have been installed. The Contractor shall minimize, to the maximum extent practicable, the length of time that excavated areas are open. He will be held responsible for damage due to weather, equipment, and other causes during periods when the excavations are left open.

1.7 The Contractor shall schedule the Works so that no excavation is left in an exposed condition for a period greater than 30 days unless otherwise approved. If the Contractor fails to meet this requirement, the Engineer may order the Contractor to suspend further excavation until the construction progress enables the Contractor to meet such requirement.

1.8 In areas where the excavation is adjacent to public highways and walkways, no excavation shall be scheduled to be left in an exposed condition for more than 7 days unless otherwise approved.

1.9 The Contractor shall schedule highway excavation and embankment and drainage Works so that they complement each other. If the Contractor's earthwork progress exceeds the progress of the drainage construction to the point where the highway becomes a dam to cross drainage, the Engineer may order the Contractor to open adequate waterways through the highway at the locations where drainage structures are to be installed. Any damage to the highway caused by water passing through these openings shall be repaired at the Contractor's expense.

1.10 The Contractor must notify the Engineer of any cracks or sign of failure, immediately when such signs are noticed.

2. Temporary Shoring and Cribbing

2.1 When shoring and/or cribbing is required to protect adjacent property or to protect the public during construction, the Contractor's design for such

shoring and cribbing shall be submitted for approval prior to commencing its construction.

2.2 All shoring and cribbing shall be designed with adequate factors of safety to serve with minimal maintenance, for the duration of its intended use, and shall include adequate safety provisions to protect the public from construction activities.

2.3 Notwithstanding any approval of temporary shoring and cribbing the Contractor shall be solely responsible for the adequacy of their construction and for maintenance and all necessary safety precautions associated therewith.

3. Excavation for Bridges, Underpasses and Overpasses and other Major Structures

3.1 The foundations for bridges, underpasses and overpasses, buildings, pumphouses and other major structures, shall be excavated in accordance with the dimensions as shown on the Drawings and shall be of sufficient size to permit the placing of the full width and lengths of the footings with full horizontal beds.

3.2 The excavation shall be carried to the elevations shown on the Drawings or as established by the Engineer. Borings and soil tests, made during design, and actual investigation of the completed foundation excavation shall be utilized by the Engineer to determine final depth. No concrete shall be placed prior to approval of the excavation pit.

3.3 The Contractor shall be responsible for ensuring by testing or otherwise that the soil at foundation level has not less than the bearing capacity as shown on the Drawings.

3.4 Unless shown otherwise on the Drawings, the bottom of all excavations shall be covered with a 75 mm minimum depth of lean (blinding) concrete Class 15 to serve as a working platform.

3.5 Foundation pits or trenches shall be of sufficient size and provide minimum sufficient working space to permit construction of structures or structure footings of the full width and length shown on the Drawings.

3.6 Where footings are to be constructed using formwork, the excavations shall generally not extend more than 500 mm beyond the maximum dimension on each side of the proposed footing unless additional working space is clearly required and approved, by the Engineer. Any unauthorised overwidth of excavation beyond the lateral limits shown on the drawings or approved by the Engineer shall be backfilled with selected fill and compacted.

3.7 Where footings are to be located, in or adjacent to firm, original ground and where formwork is not required or ordered, any unauthorized overdepth excavation below the approved elevation of base of footing shall be backfilled with blinding concrete. Any unauthorised overwidth of excavation beyond the lateral limits shown on the drawings shall be backfilled with selected fill, or blinding concrete as directed by the Engineer.

3.8 Where excavation to rock foundation is required, the excavation shall proceed in such manner as to allow the solid rock to be exposed and prepared in horizontal beds or properly serrated for receiving the concrete. All loose and disintegrated rock and thin strata shall be removed.

3.9 All blasting necessary for any pier or groups of piers or abutment shall be performed prior to placing any concrete. Blasting will not be permitted in the vicinity of concrete which has not cured for at least 14 days.

3.10 When unstable material or other unsuitable material is encountered below foundation elevation, the Contractor shall excavate such material and replace it with suitable backfill material or concrete as directed.

3.11 Where foundation piles are used, the excavation of each pit shall be completed before the piles are driven. All foundation piling shall be driven in any one pier or abutment before concrete is placed in any column of that pier or abutment. After the driving is completed, all loose and displaced material shall be removed leaving a smooth solid bed to receive the concrete.

3.12 Suitable and substantially watertight cofferdams shall be used whenever water bearing strata are encountered above the elevation of the bottom of the excavation. Cofferdams shall be placed such as to give easy access of all parts of the foundation.

3.13 Cofferdams shall be sunk to a depth below the bottom of the excavation and to the elevation necessary to adequately seal the cofferdams, shall be substantially braced in all directions, and of such construction as will permit them to be pumped free of water and kept free until the concrete has been placed.

3.14 When the bottom within the cofferdam is of sandy or porous material which will not, in the opinion of the Engineer, permit the footing to be placed in the dry, it shall be sealed in accordance with the relevant requirements of Section 5.06 "Plain and Reinforced Concrete Structures" so that it may be pumped dry. Other suitable means of sealing out the water may be approved.

3.15 If, in the opinion of the Engineer, the necessity for a seal course over the bottom is due to inadequate or improper cofferdam construction, the Engineer may order the removal and reconstruction of the cofferdam or placing of a seal course, all at the Contractor's expense.

3.16 Unless shown otherwise on the Drawings or agreed with the Engineer, cofferdams and all sheeting and bracing shall be removed after completion of concreting.

4. Excavation for Culverts, Storm Drains, Ducts & Miscellaneous Structures

4.1 Excavation shall be carried out to the limits required for construction and to the depth required for bedding material or removal of unsuitable material. All trench excavation shall proceed upgrade, commencing at the downstream end.

4.2 Foundation material supporting the bedding or structure shall be AASHTO M 145 Class A-1-a, A-1-b or A-2-4 compacted to 95% AASHTO T 180 maximum density. If the natural material does not meet the classification requirements, it shall be subexcavated to a depth of 200 mm and replaced with material meeting the specified requirements. Any rock or hard material within 200 mm of the bottom of the pipes shall be similarly subexcavated and replaced with material meeting the specified requirements.

4.3 If no special bedding material is required, the foundation for precast and prefabricated culverts shall be formed to the shape of the culvert, including all protrusions. The shaping shall extend to 25% of the height of culvert.

4.4 Where rock is encountered in the toe wall excavation for concrete box culverts or concrete headwalls or endwalls for pipe culverts and the rock is of such quality as will prevent erosion, part of the toe wall may be eliminated in the rock strata as directed and the toe wall shall be keyed into the rock strata in a satisfactory manner.

4.5 Precast concrete pipes and metal pipes if chosen shall be installed in trenches cut into previously constructed and compacted embankment or from top of subgrade. Unless otherwise shown on the Drawings, trench width shall not be greater than the external diameter of the pipe plus 600 mm on each side.

4.6 In the case of metal pipes, the bottom of the trench shall be shaped to a template so that at least 10% of the overall height of pipe or arch will be in contact with the bottom of the trench as excavated. Recesses shall be excavated to receive any parts of the pipe which extend below the outside perimeter. Where rock, hardpan or other unyielding material is encountered it

shall be removed below design grade or as ordered by the Engineer for a depth of at least 200 mm and backfilled as specified.

4.7 Trenches for cast in situ pipes shall be cut into previously constructed and compacted embankment from top of subgrade or embankment height or twice the nominal span of the pipe whichever is less. Trench width shall not be greater than the external diameter or span of pipe plus 300 mm on each side when external forms are used, or the external span of pipe plus 100 mm on each side when external forms are not used.

4.8 When excavation is required for installation of ducts, the Contractor shall notify the Engineer upon completion of the excavation. No duct shall be laid until the depth and cross section of the excavation has been approved.

2.09.3 BACKFILLING

1. General

1.1 The Contractor shall obtain approval for his proposed method and rate of placing of backfill, before backfilling commences.

1.2 Backfill materials shall be uniformly graded granular material, capable of being compacted to required compaction, and having adequate permeability to permit free drainage through it. Backfill material shall also conform to the following:

1.2.1	Minimum D10 value	1mm
	Maximum Plasticity Index	10 per cent

1.2.2. Requirement for bridges, culverts etc. specified in subsequent sections.

1.3 Backfill material shall not be placed against any structure until approval is given. Unless otherwise shown on the Drawings structures shall be backfilled to the same requirements as specified for the adjacent embankment.

1.4 Backfill shall be placed in level layers for the full width of the excavated area until the elevation of the original ground or surrounding embankment is reached. Backfill next to walls, between columns or in other confined areas, shall be compacted by approved hand or portable equipment.

1.5 Each successive layer of backfill shall contain only sufficient material to ensure proper compaction and in no case shall any layer be greater than 200 mm thickness (before compaction). The moisture content of the backfill material shall be uniform and within the moisture range designated.

1.6 Jetting of fills or other hydraulic methods involving or likely to involve liquid or semi-liquid pressure, will not be permitted.

1.7 Water shall be drained from the areas to be backfilled wherever practicable. In cases where, in the opinion of the Engineer, it is not practicable to drain the areas to be backfilled, the initial backfill material shall consist of crushed, open graded material deposited and compacted to an elevation above the water level where normal backfill operations can progress.

1.8 Additional water to be added during placement of backfill material to achieve required compaction shall be fresh water or brackish water approved by the Engineer.

1.9 Minimum tests required during backfilling operations to verify material quality are listed on Table 2.7.

TABLE 2.7

Required Tests and Minimum Repetitions for Earthworks and Structures Backfill

Control on Site (The Road)	
Required Tests	**Repetitions Required**
1. Proctor 2. Gradation of Materials 3. Plasticity Index 4. Any other Tests as required in Special Specs. and Drawings 5. Field Density	*Test for each Structure *When Materials Changed *50% of layers and for each footing and for each abutment and as per instruction of the Engineer

2. Backfilling for Bridges, Underpasses and Overpasses

2.1 Structures shall not be subject to the pressures of backfilling or to live loads until the 28-day strength of the concrete has been reached, unless a shorter period is approved in special circumstances where the load is sufficiently small as not to constitute a risk of any damage to the structure in the opinion of the Engineer. If approved this period may be extended if subnormal curing conditions exist.

2.2 Backfill placed around culverts, abutments and piers, shall be deposited on both sides to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure and slopes bounding the excavation shall be stepped, where necessary, to prevent such wedge action occurring.

2.3 All backfill intended to support falsework loads, including temporary fills and pier backfill, shall be designed for the minimum support required. As a minimum, such material shall be AASHTO M 145, Class A-1-a, A-1-b or A-2-4, compacted to 90% AASHTO T 180 maximum density.

2.4 Backfill for bridge abutments and approach embankments within 20 m of any part of the substructure shall be AASHTO M 145, Class A-1-a, A-1-b or A-2-4 compacted to 95% AASHTO T 180 maximum density up to the underside of the subgrade layer. The 200 mm minimum thickness of subgrade layer shall consist of approved topping material placed and compacted to 100% maximum density as specified under Section 2.07 - "Subgrade Construction and Topping". The backfill shall be completed to the level of the original ground or to the top elevation of any adjacent embankment.

2.5 Backfill around retaining walls shall be completed to the level of the original ground line and to such heights above original ground line or to the levels as shown on the Drawings. Care shall be exercised to prevent forward movement of the wall.

2.6 Unless shown otherwise on the Drawings, when special permeable backfill (sheathing) is to be placed against the back faces of abutments, retaining walls or wing walls, it shall consist of a continuous covering of approved type proprietary filter cloth protected by a continuous wall of 200 mm minimum thickness precast, porous (no-fines) concrete blocks laid in stretcher bond with dry joints. Prior to construction of the block wall, a Type 1 or Type 3 underdrain of at least 150 mm diameter shall be laid along the base of the wall under the sheathing in accordance with the relevant requirements of Section 8.04 - "Pipe Underdrains", where the materials for Type 1 and 3 underdrains are given.

3. Backfilling for Culverts, Storm Drains & Miscellaneous Structures

3.1 Backfill for culverts, storm drains and miscellaneous structures within 300 mm of any part of the structure shall be Class A-1-a, A-1-b or A-2-4. Backfilling and construction of the subgrade (topping) layer shall be as specified for bridges, underpasses and overpasses.

3.2 Backfill around and over pipe culverts shall not commence until headwalls and wingwalls have been constructed and attained the specified 28-day strength.

3.3 Water used for compaction of backfill around metal pipes shall be from an approved source and shall not contain more than 0.5% combined chlorides and sulphates nor contain other potentially harmful minerals.

3.4 When pipes or other structures temporarily extend above the grade of the partially constructed embankment, the Contractor shall construct the fill over the structure of sufficient depth to protect the structure from any damage resulting from construction or other traffic.

3.5 In no case shall surplus material be dumped in stream channels.

3.6 Concrete bedding, concrete cradles, concrete haunching and concrete encasement for concrete pipes shall be as specified in Section 5.13 - "Pipe Culverts, Storm Drains and Utility Ducts".

3.7 Over width or over depth excavation for precast concrete pipes shall be made good at the Contractor's expense by provision of an in situ concrete cradle or increased thickness of concrete bedding as directed, or by the use of other approved suitable materials.

3.8 Over width excavation for in situ concrete pipes shall be made good at the Contractor's expense by concrete bedding brought up to the external haunch of the pipe, or by the use of other approved suitable materials.

3.9 Over depth excavation for metal pipes shall be made good by furnishing and backfilling an approved, fine granular material containing not more than 0.5% of combined chlorides and sulfates.

3.10 The Contractor shall complete the backfill around box culverts to the level of the original ground line and to the full width of excavation area. If the top of culvert extends above the original ground line the Contractor shall continue the backfill to the top of culvert and for a width of 3 m on each side

of the culvert for the full width of highway embankment. If the embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert to the top of embankment.

3.11 Backfill around pipe culverts and storm drains shall be completed to the level of original ground line and to the full width of excavation area. If the top of the culvert extends above the original ground line the Contractor shall continue the backfill to the top of culvert for a width of 1.5 times the maximum external width of the culvert on each side of the culvert centerline to the full width of the highway embankment. If the embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert to the top of culvert or as shown on the Drawings.

3.12 Any existing highway pavement cut through, damaged or removed during excavation for pipe culvert installation shall be reinstated, after pipe installation and trench backfilling, using approved base and surfacing course materials at least equivalent to those in the original pavement. Materials and construction shall conform with the relevant requirements of Section 4.10 - "Pavement Repairs and Trench Reinstatement Works".

3.13 Miscellaneous structures other than pipe culverts and storm drains shall be backfilled in accordance with the methods specified. Compaction of backfill when structures are outside the highway right-of-way or in approach roads, minor roads or similar areas, shall be to 90% AASHTO T 180 maximum density.

2.09.4 MEASUREMENT

1. Structural backfilling shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Structural Excavation or Subexcavation of Unsuitable Material, as appropriate.

2. All structural excavation, of whatever type, shall be measured as "unclassified" which shall be deemed to include all materials encountered of any nature, including silts, clays, sand, gravel and granular materials and fractured, jointed and solid rock.

3. Structural excavation for box culverts less than one sq.m in external cross section and structural excavation for pipe culverts, storm drains, ducts, underdrains (subsoil drains), pits, catchbasins, manholes, inlets, energy dissipators, slope protection Works, fence posts, guardrail posts, lighting columns, sign posts, signal supports and all other minor structures, shall not be measured for direct payment, but shall be considered as subsidiary Works the

costs of which will be deemed to be included in the Contract Prices for Pay Items.

4. Structural Excavation shall be measured by cubic meter of material excavated for the major structures specified in Clause 3 above, hauled away and disposed of as directed, or stockpiled on or in the vicinity of the Works, and the excavated areas backfilled, completed and accepted.

5. Measurement of structural excavation shall be of original ground elevations, or ground elevations after removal of all unclassified highway excavation. Limits shall not be greater than vertical planes 500 mm from the maximum dimension, on each side of the footing or other controlling portion of the structure. Where structures are to be constructed against natural ground or rock, excavation limits shall be the dimensions of the structure as shown on the Drawings. Bottom limits shall be the ordered foundation elevations. Only material excavated from its original position shall be measured for payment. No measurements shall be made of structural excavation in embankments previously constructed by the Contractor.

6. Subexcavation of Unsuitable Material shall be measured by cu.m of unsuitable material subexcavated as ordered, hauled away and disposed of as directed, and the excavated areas backfilled, completed and accepted. Measurements shall be of volumes computed from the cross sections and depths of excavation ordered by the Engineer.

7. Unauthorized overdepth and overwidth excavation and the concrete backfill required in such cases, shall not be measured for direct payment, but shall be considered as Subsidiary Works the costs of which will be deemed to be included in the Concrete Prices for Pay Items.

8. Temporary cofferdams, temporary shoring and cribbing, bailing, drainage, pumping, sheeting, and all other Temporary Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

PAY ITEMS		UNIT OF MEASUREMENT
(1)	Unclassified Structural Excavation	Cubic meter (cu.m)
(2)	Subexcavation of Unsuitable Material	Cubic meter (cu.m)

SECTION 2.10: RECONSTRUCTION OF EXISTING FARM DIKES

2.10.1 SCOPE

1. These Works shall consist of furnishing materials and reconstructing sections of existing farm dikes that have been partially or totally excavated in order to permit new highway construction, and furnishing materials and constructing new diversion and spur dikes.

2. Construction of diversion dikes shall consist of placing material to the lines and grades required to intercept and divert the flow of surface water to an appropriate discharge or dispersion point.

3. Construction of spur dikes shall consist of placing material to the lines and grades required to channel surface water away from bridge abutments.

2.10.2 MATERIALS

1. Only approved materials from the roadway excavation, drainage excavation, structural excavation, or borrow may be used to reconstruct existing farm dikes, or construct new diversion or spur dikes.

2. Riprap and Construction Fabric shall be of the types shown on the Drawings and shall conform with the relevant requirements of Section 8.05 - "Slope Protection and Stabilization".

2.10.3 CONSTRUCTION

1. Reconstruction of existing farm dikes shall include rebuilding of existing improvements, at or near the same location, to either new lines, grades and cross sections, or to their original lines, grades and cross sections, as indicated on the Drawings.

2. Farm dikes shall be compacted in an approved manner and to a density at least equivalent to the density of material in the original dike or as otherwise directed.

3. Reconstruction of existing farm dikes, and construction of diversion and spur dikes, shall be as shown on the Drawings and in accordance with the relevant requirements of Section 2.03 - "Highway Excavation" and Section 2.06 - "Embankment Construction". All material shall be compacted to 95% AASHTO T 180 maximum density, unless otherwise specified.

4. Construction fabric and riprap shall be installed on spur dikes and diversion dikes wherever shown on the Drawings. The installation of riprap and construction fabric shall conform with all relevant requirements of Section 8.05 - "Slope Protection and Stabilization". Fabric damaged or unduly displaced by dumping or otherwise of riprap, shall be replaced at the Contractor's expense.

2.10.4 MEASUREMENT

1. Reconstruction of Existing Farm Dikes shall be measured by cubic meter (cu.m) constructed including the furnishing of all materials, compacted, completed, and accepted.

2. Spur Dikes and Diversion Dikes shall be measured by cubic meter (cu.m) in place of material furnished, placed, compacted, completed, and accepted. Quantities measured as Farm Dikes, Spur Dikes, or Diversion Dikes shall not also be included under embankment quantities.

3. Riprap shall be measured by cubic meter (cu.m) of each type furnished, placed, completed, and accepted in accordance with drawings.

4. Construction Fabric shall be measured by sq. m furnished, placed, secured, completed and accepted.

PAY ITEM		UNIT OF MEASUREMENT
(1)	Reconstruction of Existing Farm Dikes	Cubic meter (cu.m)
(2)	Construction of Spur Dikes and Diversion Dikes	Cubic meter (cu.m)
(3)	Loose Stone Riprap	Cubic meter (cu.m)
(4)	Mortared Stone Riprap	Cubic meter (cu.m)
(5)	Construction Fabric	Square meter (sq.m)

SECTION 2.11: TEMPORARY SOIL EROSION CONTROL

2.11.1 SCOPE

1. These Works shall consist of temporary control measures as shown on the Drawings or required by the Engineer during progress of the Works, to control soil erosion and water pollution, by use of berms, dikes, silt fences, brush barriers, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

2. The temporary erosion control provisions shall be coordinated with permanent erosion control features to assure economical, effective and continuous erosion control throughout the period of the Works.

2.11.2 MATERIALS

1. Geotextile or jute matt lining or any other approved material as appropriate can be used for soil erosion control.

2. All other materials shall meet commercial grade standards and be approved before being incorporated in the Works.

2.11.3 CONSTRUCTION

1. **Control Measures Generally**

1.1 A schedule of proposed temporary (and permanent) soil erosion control Works shall be developed by the Contractor at the commencement of the Contract, in consultation with the Engineer and to his satisfaction.

1.2 The Contractor shall carry out (and maintain) temporary erosion control to prevent soil erosion that will adversely affect construction operations, damage adjacent properties, or cause contamination of adjacent streams or other watercourses, lakes, ponds or other areas of water impoundment. Such Works may involve construction of temporary berms, dikes, dams, sediment basins, slope drains or use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds, to the extent considered desirable and practicable by the Engineer.

1.3 Temporary erosion control may include construction outside the right-of-way where such work is necessary, as a result of roadway construction, such as borrow pit operations, haul roads and equipment storage sites.

1.4 The Contractor shall incorporate all permanent erosion control features as shown on the drawings into the Works at the earliest practicable time as outlined in his schedule, to minimize the need for temporary erosion control measures.

1.5 Where erosion is a problem, clearing and grubbing operations shall be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.

1.6 The Engineer will limit the area of clearing and grubbing, excavation, borrow and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finished grading, mulching, seeding and other permanent erosion control measures current in accordance with the schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

1.7 The Engineer may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.

1.8 In the event that temporary erosion control measures are required due to the Contractor's negligence, carelessness or failure to install permanent controls as part of the Works, scheduled or ordered by the Engineer, such Works shall be carried out by the Contractor at his own expense.

2.11.4 MEASUREMENT

1. The Works prescribed in this Section shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for Pay Items.

SECTION 2.12: SAND DUNE STABILIZATION

2.12.1 OBJECTIVES

1. The destruction or stabilization of wind blown sand accumulation in order to prevent further migration and encroachment.

2. The diversion of wind blown sand around works requiring protection.

3. Stopping sand movement in front of the works to be protected.

4. Aiding sand movement in order to avoid desposition over a specific location, especially by surface smoothing and obstacle removal.

2.12.2 SCOPE

1. The above objectives are achieved by the use of one or more methods of surface modifications summarised below. The following methods are listed with potentially more attractive ones first.

2.12.3 METHODS

1. Alignment: Align route upwind of sand source to avoid major dune fields.

2. Oiling: Oiling involves the covering of wind blown materials with a suitable oil product such as high gravity surface and may destroy dune forms. This is often a quick, cheap and effective method.

3. Fencing: The use of relatively porous barriers to stop or divert sand movement or destroy or stabilize dunes, cheap portable and expendable structures are suitable such as palm fronds, chicken wire or snow fencing.

4. Planting: Planting of appropriate vegetation designed to stop or reduce sand movement, bind surface sand and provide surface protection.

5. Paving: Paving shall be designed to increase the saltation coefficient of wind transported material by smoothing or hard surface of relatively level areas. Paving can be with concrete asphalt or windstable aggregates such as crushed rock or gravel.

2.12.4 MEASUREMENT

1. Unless shown in the Bill of Quantities or otherwise specified in the Special Specifications, the works prescribed in this section shall not be measured for direct payment, but shall be considered as subsidiary works the cost of which will be deemed to be included in the contract prices for Pay Items.

Part (3)

Sub-base & Base Courses

SECTION 3.01: MATERIALS

3.01.1 SCOPE

1. Materials specified for use in the construction of the sub-base and base courses for flexible and rigid pavements, may include any or all of the following:

1.1 Granular screened material, or partially crushed of approved classes, consisting of well graded gravel including sand and silt, or crushed stone or crushed gravel for sub-base course construction.

1.2 Crushed stone , of approved classes, for base course construction.

1.3 Stabilizing materials including portland cement, bitumen and lime, used where specified in sub-base and base courses (and in subgrades).

2. All material sources and the quality of materials proposed for use in the Works shall be approved prior to procuring or processing material from such sources. Inspection, sampling, testing and retesting as necessary, shall be at the Contractor's expense as prescribed in Section 1.06 - "Control of Materials and Standards for Sampling and Testing" and as specified hereunder for specific materials.

3. Depending upon the location of the works, the estimated traffic and the results of the material survey, the designer may find it difficult to obtain the required materials, as required in the General Specification, within an economic distance from the works. The designer may, with the approval of the MPWH, relax the requirements of the General Specification to allow locally available materials to be used for base and subbase courses. Such relaxation of the General Specification requirements will be part of the Special Specification for the particular work, and will not in any way reduce the standard of the work on the requirements of the MPWH.

4. Storage and handling of all materials shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing". Materials shall be stored on hard, clean surfaces or as directed by the Engineer.

3.01.2 GENERAL

1. Sources and Production

1.1 Locating sources and manufacturers of materials in accordance with the requirements of the Specifications are the responsibility of the Contractor, who

shall produce the required granular materials and aggregates at the rates and in the quantities necessary to complete the Works on time.

1.2 The Contractor shall have satisfied himself as to the location, suitability and quantity of materials available; extent of work necessary to obtain the material available; the work required to open the quarry and to crush, screen and wash the materials; and the length of haul to the Site.

1.3 Prior to starting quarry or borrow pit operations, the Contractor shall obtain written permission from the Authorities or Owners concerned.

1.4 Screening plants or crushing and screening plants shall not be put into operation prior to their approval. If, after any plant is put into operation, it fails to perform as intended, the Contractor shall either rectify the defects in the existing plant to the satisfaction of the Engineer, or shall provide alternative approved plant.

1.5 Approval of the crushing and screening plants and other equipment shall in no way relieve the Contractor of his responsibilities in respect of producing granular materials and aggregates which conform to the Specifications and in the quantities required for the completion of the Works on time.

2. Stockpiling

2.1 Stockpile areas shall be surveyed prior to stockpiling to establish control points and to obtain a record of existing cross sections for future use in determining stockpile quantities. The areas shall be adequately drained at all times.

2.2 Stockpiling procedures shall not result in noticeable degradation or segregation of the stockpiled material, or introduction of foreign materials into the stockpile, or coning. Heights of granular material and aggregate stockpiles shall not exceed 3 m. berms.

3. Sampling and Testing

3.1 Sampling and testing procedures shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing" and with the following requirements.

3.2 The Contractor shall submit to the Engineer, 10 days prior to the scheduled beginning of crushing and screening operations, a statement of origin and composition of all stone and/or gravel aggregates and granular materials proposed for use in the Works.

3.3 In order to ascertain the properties of granular and aggregate materials, the Contractor shall submit for testing and approval, representative samples of all materials intended for incorporation in the Works, prior to starting quarry or borrow pit operations. The representative samples shall be taken by the Contractor in the presence of the Engineer.

3.4 Tests performed by the Contractor shall be utilized in assessing the locations, extent of deposits and quantities of materials which will conform to the Specifications when properly processed, and shall in no way obviate the need for further testing by the Engineer. Approval of specific sources of materials shall not be construed as final approval and acceptance of materials from such sources.

3.5 The Contractor may conduct necessary tests in the Field Laboratory in the presence of the Engineer and the Contractor's Materials Engineer.

3.6 Processed materials shall be tested and approved before being stockpiled on Site or incorporated in the Works and may be inspected and tested at any time during their preparation, storage and use. Questionable materials, awaiting testing and approval, shall not be unloaded and mixed with materials previously approved. If the grading and quality of any materials delivered to the Site do not conform to the grading and quality of the established control samples, the Engineer will reject such materials.

3.7 Samples shall satisfy all specified test requirements. The Contractor shall permit the Engineer to inspect any and all materials used or to be used, at any time during or after their preparation, or while being used during progress of the Works. Unsatisfactory materials, whether in place or not, shall be removed promptly from the Site. The Contractor shall furnish all necessary labor, transport, tools and equipment required by the Engineer for such inspections.

3.01.3 GRANULAR MATERIAL FOR SUB-BASE

1. Granular material for use in sub-base courses, shall be a naturally occurring gravel, blended as necessary with fine or coarse material and screened to produce the specified gradation. Crushing of natural granular material shall not normally be required, unless for the purpose of meeting the gradation requirements, or when shown on the Drawings (to produce a higher quality sub-base with improved mechanical stability).

2. Gravel shall consist of hard, durable and sound stones, free from deleterious substances not mentioned below . Other requirements are:

Crystalline gypsum (expressed as SO3)	5% max.
Clay lumps and friable particles	10% max.
Flakey and elongated particles as follows:	
Crushed rock	40% max. each
Crushed gravel	45% max. each
Natural gravel	50% max. each

(Determined in accordance with BS812 Section 105.1: 1985 and BS812 Part 1: 1975)

Maximum dry density (gm/cm3)	2.05 min.

Chert content (determined by percentage by weight insoluble in hydrochloric acid) to be spesify in special technical specification .

3. Granular materials delivered to the road site shall meet the requirment of class A or B as shown in table 3.1, when tested in accordance with AASHTO T-27 after dry mixing and just befor spreading and compacting . The Class of granular material to be used shall be as shown on the Drawings or otherwise as selected by the Engineer. The actual gradation shall, in all cases, be continuous and smooth within the specified limits for each Class. If gradation is tested after compaction, a tolerance of 3% is allowed in the upper limit for the percentage of material passing sieve no. 200 .

Table 3.1: Gradation of Granular Material by Class

Sieve Designation (square openings)		Per cent by weight passing	
		Class A	Class B
63	mm (2 - 1/2 in.)	100	
50	mm (2 in.)	80 - 100	100
37.5	mm (1 - 1/2 in.)	70 - 95	80 - 100
25	mm (1 in.)	55 - 90	60 - 95
12.5	mm (1/2 in.)	45 - 75	47 - 80
4.75	mm (No.4)	30 - 60	30 - 60
2.00	mm (No. 10)	22 - 48	22 - 45
0.425	mm (No.40)	10 - 30	10 - 30
0.075	mm (No. 200)	5 - 12	5 - 12

4. The material shall contain a minimum of 25% sand equivalent at any stage of construction .

5. The loss in weight of granular material shall not exceed 15% after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion Test).

The ratio of wear loss = $\frac{\text{Abrasion after 100 Rev.}}{\text{Abrasion after 500 Rev.}}$, should not be more than twenty percent of the maximum allowed abrasion after 500 revelution .

6. The granular material shall have a 4-day soaked CBR of not less than 40 when compacted at 100% of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

7. When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the percentage loss in weight after 5 cycles shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

8. The portion of granular material, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit (L.L.) of not more than 30 and a plasticity index (P.I.) shall neither be less than 2 nor grater than 8 when tested in accordance with AASHTO T 89 and T 90.
Non Plastic condition might be accepted if crushed lime stone is use provided that angularity test (R) value shall not be less than 8 .

9. If additional fine material is required to correct the gradation of the granular material, or for adjusting the L.L. or P.I. of the fraction passing 0.425 mm (No 40) sieve, it shall be uniformly blended and mixed with the granular material. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or slag, if naturally occurring fine material is not available.

3.01.4 AGGREGATE FOR BASE COURSES

1. Aggregate for use in base course construction shall be crushed stone . Aggregate may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

2. Crushed stone and crushed gravel shall consist of hard, durable and sound particles or fragments of stone, free from other deleterious substances not mention below , other requirements are gypsum, or flakey particles. Other requirements:

Gypsum content (expressed as SO3)	2% max.
Clay Lumps and friable particels	8% max.
Elongated and flakey particles for crushed rock (Determined in accordance with BS812 Part 1: 1975)	
Granit & Basalt	40% max. each
Lime Stone	35% max. each
Maximum Dry density (g/cm3)	2.1 min.

Chert content (determined as percentage by weight insoluble in hydrochloric acid to be spesified in special technical specification .

3. Methods used in production of crushed rock shall ensure that the finished product will be as uniform as practicable. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve at least 80% by weight shall have at least two factured faces.

4. Any material passing 4.75 mm (No. 4) sieve and produced in the crushing process shall be incorporated in the base material up to the gradation limits for the particular Class of aggregate involved.

5. Crushed aggregate for base course delivered to road site shall meet the requirements of Class A or Class B gradations as shown in Table 3.2, when tested in accordance with AASHTO T 27 after dry mixing and just befor spreading and prior to compacting. The Class of aggregate to be used shall be as shown on the Drawings or otherwise as selected by the Engineer. The actual gradation shall, in all cases, be continuous and smooth within the specified limits for each Class. Gap graded aggregate will not be accepted . If

gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200 .

Table 3.2: Gradation of Base Course Aggregate by Class

Sieve Designation (square openings)		percent by weight passing Class A	Class B
50	mm (2 in.)		100
37.5	mm (1 - 1/2 in.)	100	70 - 100
25	mm (1 in.)	75 - 100	55 - 85
19.0	mm (3/4 in.)	60 - 90	50 - 80
12.5	mm (1/2 in.)	45 - 80	- -
9.5	mm (3/8 in.)	40 - 70	40 - 70
4.75	mm (No. 4)	30 - 65	30 - 60
2.00	mm (No. 10)	20 - 40	20 - 50
0.425	mm (No.40)	8 - 20	10 - 30
0.075	mm (No. 200)	5 - 10	5 - 15

The material shall contain a minimum of 35% sand equivalent at any stage of constraction.

6. The loss in weight shall not exceed 45% after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion Test).

The ratio of wear loss = $\frac{\text{Abrasion after 100 Rev.}}{\text{Abrasion after 500 Rev.}}$, should not be more than twenty percent of the maximum allowed abrasion after 500 revelution .

7. The crushed aggregate base course material shall have a 4-day soaked CBR of not less than 80 when compacted at 100% of modified proctor AASHTO (T180-D) and tested in accordance with AASHTO T 193.

8. When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the loss by weight shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

9. The portion of aggregate, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit (L.L.) of not more than 25 and plasticity index (P.I) of not more than 6 when tested in accordance with AASHTO T 89 and T 90. In case of using cohsionless base course material the exposed surface shall exhibit intact and coherent surface to resist water erosion and fretting, the contractor at his own expense shall ensure such property any solution should not applied unless approved in writing by Engineer , such solution may include single bituminous surface treatment , bonding material and other necessary treatment all as directed and approved by the engineer . Provided that angularity test should be more than 8 .

10. If additional fine material is required to correct the aggregate gradation, or for adjusting the L.L. or P.I. of the fraction passing the 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the aggregate material. Reworking of the material in situ to obtain the specified gradation will be permitted. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or natural material.

3.01.5 STABILIZING AGENTS

1. Cement as Stabilizing Agent

1.1 Cement shall be portland cement conforming to AASHTO M 85 Type II, or sulphate resistant portland cement conforming to AASHTO M 85, Type V, as specified in the Special Specification.

2. Bitumen as Stabilizing Agent

2.1 Bitumen may include straight run (penetration grade) bitumen; RC cutback bitumen, MC cutback bitumen, or cationic emulsified bitumen, Type SS. Penetration grade, cutback bitumen and emulsified bitumen shall conform with all relevant requirements herein.

2.2 The selection of a suitable bitumen will depend on the properties of the material to be stabilized and shall be subject to laboratory and field trials by the Contractor, under the supervision of the Engineer.

2.3 When the material moisture content is high and material must be dried, the use of penetration grade bitumen or viscous cutback bitumen and plant mixing of materials are appropriate.

2.4 When the natural moisture content of the material is low, cutback bitumens or emulsified bitumens are appropriate.

3. Lime as Stabilizing Agent

3.1 Hydrated lime (calcium hydroxide) and quicklime (calcium oxide) shall conform to AASHTO M 216. Mixing of different brands of lime or use of lime from different mills will not be permitted.

3.2 Lime slurry shall be a homogeneous pumpable mixture of lime and water. Slurry shall be a premixed material in which the lime solids content shall be not less than 30% by weight.

3.01.6 MEASUREMENT

1. Granular, aggregate and stabilized materials for Sub-base and Base Courses shall be measured as prescribed in the appropriate Sections of these Specifications.

SECTION 3.02: GRANULAR SUB-BASE COURSES

3.02.1 SCOPE

1. These Works shall consist of furnishing granular sub-base material of the required Class, mixing, spreading on prepared subgrade, compacting and finishing, all as and where shown on the Drawings.

3.02.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 3.01 - "Materials", in respect of granular material Class A or Class B for sub-base construction.

3.02.3 SUBGRADE SURFACE PREPARATION

1. The subgrade shall have previously been constructed in accordance with the requirements of Section 2.07 - "Subgrade Construction and Topping" and properly maintained and kept well drained thereafter.

2. At all special grade control points, such as at bridge structures, existing pavements, etc the subgrade shall be lowered to a depth sufficient to permit construction of the sub-base course to the specified elevations and thickness. Transitions shall be of sufficient length to avoid abrupt changes of grade and shall be within plus or minus 3% of the final design grade unless otherwise directed. Surplus material shall be removed and disposed of.

3. The subgrade shall be inspected and approved immediately prior to commencement of sub-base construction. Any soft, yielding material shall be removed and replaced by approved topping material. Holes, depressions and other irregularities shall be made good as directed and the subgrade recompacted as necessary and finished ready to receive the sub-base course.

3.02.4 EQUIPMENT

1. Equipment used to handle, place, spread, water, compact and finish sub-base shall conform with the requirements of Section 1.12 - "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

3.02.5 CONSTRUCTION OF TRIAL SECTIONS

1. Before commencement of Site sub-base construction, the Contractor may be required to lay and compact trial sections of varying thickness of sub-base. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site. Each trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures, proposed for use in the Works.

2. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment, the loose depth measurements that will result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the sub-base material.

3. The Contractor shall not proceed with sub-base construction until the methods and procedures established in the trials have been approved.

3.02.6 CONSTRUCTION

1. Stockpiling of Granular Material

1.1 Stockpiling procedures shall conform with the relevant requirements of Section 3.01 - "Materials".

1.2 Methods used for stockpiling granular material and removing it from stockpiles shall not result in significant degradation or segregation nor the introduction of significant amounts of foreign materials or extraneous matter.

1.3 Granular material adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures, shall not be incorporated in the Works regardless of previous approval of such material, until the deficiencies have been rectified in an acceptable manner.

2. Mixing and Spreading

2.1 All components of sub-base course material shall be mixed thoroughly and uniformly with water in situ. The amount of water added, as approved by the Engineer, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. Wetting of granular material in stockpiles or in trucks before or during delivery to the Site will not be permitted. However, water shall be added to the material, if necessary, during placing and compaction of sub-base material.

2.2 The sub-base material shall be placed on the subgrade in a uniform layer or layers not exceeding 200 mm thickness (after compaction). Where the required uncompacted thickness is greater than 250 mm but less than 500 mm, the material shall be placed in layers of equal thickness.

2.3 If approved, heavy duty vibratory compaction equipment is used, the maximum layer thickness may be increased up to 300 mm (after compaction) provided compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness .

2.4 The sub-base material shall be placed to the required width using a self-propeled spreader or a motor grader equipped with blade extensions. Water shall be applied by approved spraying equipment and thoroughly mixed with the sub-base material.

2.5 The material shall not be handled in such a way as to cause segregation. If the spreading equipment causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the equipment, the use of such equipment shall forthwith be discontinued and it shall be replaced by a spreader or grader capable of spreading the material in a proper manner.

2.6 All segregated material shall be removed and replaced with well-graded material. "Skin" patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

2.7 Neither hauling nor placement of material will be permitted when, in the judgement of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting or rutting of the subgrade or cause contamination of the sub-base material.

3. Compaction

3.1 The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out as directed and at the Contractor's expense.

3.2 The sub-base material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass.

3.3 Rolling shall continue until the entire thickness of each sub-base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 (Method D) maximum density. Final rolling of the completed course shall be by means of an approved self-propeled roller. Rolling shall be accompanied by sufficient blading, to insure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied in an approved manner.

3.4 Any areas inaccessible to normal compaction equipment shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.

3.5 Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.

3.6 Prior to placing a subsequent layer, the existing surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

3.7 The edges and edge slopes of the sub-base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

3.8 Material which has dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedures. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall remove the material and reconstruct the sub-base course on a re-approved subgrade.

4. Tolerances

4.1 The fully compacted and completed sub-base course shall conform to the lines, grades and cross sections as shown on the Drawings.

4.2 The elevations of the finished sub-base course shall be checked by the Contractor in the presence of the Engineer at maximum intervals of 10 m and at intermediate points as directed.

4.3 The tolerances on elevations of finished surface shall be plus 10 mm to minus 20 mm , minus tolerance shall be compensate by the proceeding layer .

4.4 When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 10 mm.

4.5 All areas which exceed the specified tolerances shall be corrected by removing the defective sections of sub-base and reconstructing them or, if approved, by adding new material mixing and recompacting and finishing to the specified standard.

5. **Maintenance of Completed Sub-base**

5.1 Following completion and acceptance of the sub-base course, it shall be maintained by the Contractor at his own expense. The sub-base shall be bladed, broomed and otherwise maintained, keeping it free from raveling and other defects until such time as the base course is placed. Water shall be applied at such times and in such quantities as directed by the Engineer.

3.02.7 TESTING

1. Every 500 lin.m of sub-base material or whenever there is a change in the material source shall be subject to a full set of tests after mixing in situ and, if found satisfactory, shall be approved for compaction. This approval shall not be deemed to constitute acceptance of the sub-base course.

2. Sampling and testing shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing".

3. Compaction shall be tested in accordance with AASHTO T 191 or AASHTO T 205. If there is a delay between the construction of any layer and the following layer, if necessary and required by the Engineer the compaction of the lower layer may be reverified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

3.02.8 MEASUREMENT

1. Granular Sub-base Course shall be measured by cu.m of granular material furnished, screened, crushed if so specified, mixed with water, placed, spread, compacted and finished, completed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and of the field measurements of area and compacted depth of each Trial Section.

2. No measurement shall be made for direct payment of overdepth construction, regardless of the Engineer's permission for it to remain in place.

PAY ITEM	UNIT OF MEASUREMENT
(1) Granular Sub-base Course	Cubic meter (cu.m)

SECTION 3.03: AGGREGATE BASE COURSES

3.03.1 SCOPE

1. These Works shall consist of furnishing crushed aggregate base course material of the required Class, mixing, spreading on prepared sub-base course, compacting and finishing, all as and where shown on the Drawings.

3.03.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 3.01 - "Materials", in respect of crushed aggregate Class A or Class B for base course construction.

3.03.3 SURFACE PREPARATION

1. Where a sub-base course is present, it shall have previously been constructed in accordance with the requirements of Section 3.02 - "Granular Sub-base Courses" and properly maintained and kept well drained thereafter.

2. The sub-base surface shall be inspected and approved prior to commencement of base construction. Holes, depressions and other irregularities shall be made good as directed and the sub-base recompacted as necessary and finished ready to receive the base course.

3. Where sub-base course is omitted in the contract drawing and the aggregate base course is placed directly on completed subgrade, preparation of the subgrade surface shall be as specified in Section 3.02 - "Granular Sub-base Courses".

3.03.4 EQUIPMENT

1. Equipment used to handle, place, spread, water, compact and finish base course shall conform with the requirements of Section 1.12 - "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

3.03.5 CONSTRUCTION OF TRIAL SECTIONS

1. If the Engineer deems it necessary the Contractor shall lay and compact trial sections of varying thickness of base. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site. Each trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures, proposed for use in the Works.

2. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment, the loose depth measurements that will result in the specified compacted layer depths, the field moisture content for compaction, and the relationship between the number of compaction passes and the resulting density of the base course material.

3. The Contractor shall not proceed with base course construction until the methods and procedures established in the trials have been approved.

3.03.6 CONSTRUCTION

1. Stockpiling of Aggregate Materials

1.1 Stockpiling procedures shall conform with the relevant requirements of Section 3.01 - "Materials".

1.2 Methods used for stockpiling aggregate materials and removing them from stockpiles shall not result in significant degradation nor the introduction of significant amounts of foreign materials or extraneous matter.

1.3 Aggregate materials adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures, shall not be incorporated in the Works regardless of previous approval of such material, until the deficiencies have been rectified in an acceptable manner.

2. Mixing and Spreading

2.1 All components of base course material may be premixed with water, in a pugmill mixing plant or on site. The amount of water added, as determined, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. The Engineer may allow other methods of mixing provided such method(s) do not reduce the standard of work required by the MPWH. If such alternative mixing methods are allowed the Contractor will be required to demonstrate, in the presence of the Engineer, his ability to attain the requirement given in the General Specification or Special Specification as applicable.

2.2 The premixed material shall be placed on the sub-base in a uniform layer or layers not exceeding 250 mm in thickness (before compaction). Where the required uncompacted thickness is greater than 250 mm but less than 500 mm, the material shall be placed in layers of equal thickness

2.3 If approved, heavy duty vibratory compaction equipment is used, the maximum layer thickness may be increased up to 350 mm (after compaction)

provided compaction tests indicate that the specified compaction standard will be attained.

2.4 The base course material shall be placed to the required width using a self-propeled spreader or motor grader, and shall be delivered such that it is ready for compaction without further shaping.

2.5 The material shall not be handled in such a way as to cause segregation. If the spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the spreader operation, the use of such spreader shall forthwith be discontinued and it shall be replaced by a spreader capable of spreading the material in a proper manner.

2.6 All segregated material shall be removed and replaced with well-graded material. "Skin" patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

2.7 Hauling or placement of material will not be permitted when, in the judgement of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting or rutting of the sub-base or subgrade or cause contamination of the base course material.

3. Compaction

3.1 The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out in an approved manner and at the Contractor's expense.

3.2 The base course material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass.

3.3 Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 (Method D) maximum density. Final rolling of the completed course shall be by means of an approved self-propeled roller. Rolling shall be accompanied by sufficient blading, to ensure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied in an approved manner.

3.4 Any areas inaccessible to normal compaction equipment shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved, or to the satisfaction of the Engineer.

3.5 Each layer shall be completely compacted and approved prior to delivery of materials for the following layer.

3.6 Prior to placing a following layer, the surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

3.7 The edges and edge slopes of the base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

3.8 Material which has dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedures. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, for the final layer only the Contractor shall scarify the material and reconstruct the base course on a re-approved sub-base surface or to the satisfaction of the Engineer.

4. Tolerances

4.1 The fully compacted and completed base course shall conform to the lines, grades and cross sections as shown on the Drawings.

4.2 The elevations of the finished base course shall be checked by the Contractor in the presence of the Engineer at intervals of 20m on straight lines and of 10 m on curves, and at intermediate points as directed.

4.3 The tolerances (for final layer only) on elevations of finished surface shall not exceed +10mm or -15mm.

4.4 When the finished surface is tested with a 4 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 12 mm.

4.5 All areas which exceed the specified tolerances shall be corrected by removing the defective sections of base course and reconstructing them or, by scarifying and adding new material and recompacting and finishing to the specified standard.

5. Maintenance of Completed Base

5.1 Following completion and acceptance of the base course, it shall be maintained by the Contractor at his own expense. The surface shall be broomed, rolled and otherwise maintained, keeping it free from raveling and other defects until such time as the following course is placed. Water shall be applied at such times and in such quantities as directed.

Table 3.3 Required Tests and Minimum Repetition for Sub-Base course Material

Source of Materials		Control on Site (The Road)	
Required Test (A)	Repetition Required for all Tests in (A)	Required Tests (B)	Repetition Required for all Tests in (B)
1. Gradation of Materials 2. Plasticity Index 3. Abrasion 4. C.B.R. 5. Sand equivalent 6. Percentage of fractured Grains/Basecourse 7. Any other tests as required in Tech. Specs and drawings	*Test for each source *For every 2000 cum. *When Materials changed	1. Proctor 2. Gradation of Materials 3. Plasticity Index 4. C.B.R. 5. Abrasion 6. Sand equivalent 7. Clay Lumps & Friable particles 8. Any other tests as required in Tech. Specs. and drawings 9. Field Density 10. Thickness	*Test for every 500 LM for each layer. *When Materials changed * Test for every 730 sq.m. and for every layer

3.03.7 TESTING

1. Sub-Base and Base course material shall be tested in accordance with Table 3.3 at stock pile and at the mixing plant for source of material tests and in-situ after dry mixing piriorte spreading and compaction for control on site tesrs and if satisfactory shall be approved for use. This approval shall not be deemed to constitute acceptance of the base course for full payment purposes.

2. Sampling and testing shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing".

3. Compaction shall be tested in accordance with AASHTO T 191, AASHTO T 205 or any acceptable method. If there is a significant delay between the construction of any layer and the following layer, the Engineer may require the compaction of the lower layer to be reverified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

3.03.8 MEASUREMENT

1. Aggregate Base Course shall be measured by cu.m of aggregate materials furnished, crushed and screened, mixed with water, placed, spread, compacted and finished, completed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and of the field measurements of area and compacted depth of each Trial Section.

2. No measurement shall be made for direct payment of overdepth construction, regardless of the Engineer's permission for it to remain in place.

PAY ITEM	UNIT OF MEASUREMENT
(1) Aggregate Base Course	Cubic meter (cu.m)

SECTION 3.04: STABILIZED COURSES

3.04.1 SCOPE

1. These Works shall consist of furnishing, mixing, spreading, compacting and finishing courses composed of sand, sandy gravel, sandy clay soil or similar (and including granular material which does not meet the standards specified for sub-base) stabilized with cement or bitumen or lime as appropriate, as and where shown on the Drawings.

3.04.2 MATERIALS

1. Cement, bitumen and lime for use as stabilizing agents shall conform with the relevant requirements of Section 3.01 - "Materials". Unless shown on the Drawings the Engineer will determine the type of cement to be used or the type and grade of bitumen to be used, or whether hydrated lime or quicklime shall be used.

2. The material to be stabilized shall conform with the gradation and other requirements specified for the particular stabilizing agent to be used.

3. Curing seal shall consist of an approved proprietary curing compound, or MC-70 cutback bitumen to Prime Coat standard as specified in Section 4.01 - "Materials" and Section 4.02 - "Bituminous Prime and Tack Coats".

4. Water shall be potable and shall conform with the relevant requirements of Section 5.01 - "Concrete and Concrete Mixes and Testing".

3.04.3 SURFACE PREPARATION

1. Prior to placing of stabilized sub-base on subgrade, the subgrade shall have been properly completed and approved as specified in Section 2.07 - "Subgrade Construction and Topping" or Section 2.08 - "Stabilized Subgrade Construction".

3.04.4 CONSTRUCTION OF TRIAL SECTION

1. If the Engineer requires it, before commencement of Site stabilization Works and after completion of laboratory mix design, the Contractor shall lay a trial section of stabilized material 2 lanes wide by 50 m long, at an approved location on or near to the Site. This trial section shall be laid using the same materials, mix proportions, mixing, spreading and compaction equipment, and construction procedures that are proposed for use in the Works.

2. The trial section shall serve as a field verification of the laboratory mix design. The results of the dry density and moisture content measurements made in the trial section will be used in association with the laboratory tests to establish the moisture content and minimum per cent compaction to be attained in the Site stabilization Works.

3. The trial section shall also demonstrate the adequacy of mixing, spreading and compaction equipment and the suitability of the methods and organization proposed.

3.04.5 CEMENT STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized shall be a sandy or gravelly soil of low plasticity or aggregate, which conforms to the following gradations:

Table 3.4: Sandy and Gravelly Soils

Sieve No.			% by weight passing	
			Aggregate	Soil
50	mm	(2 in.)	100	
20	mm	(3/4 in.)	60 - 95	100
4.75	mm	(No 4)	15 - 75	50 - 100
0.425	mm	(No 40)	10 - 35	15 - 60
0.150	mm	(No 100)	5 - 15	5 - 30
0.075	mm	(No 200)	0 - 5	0 - 10

1.2 The cement content and optimum moisture content for the proposed mix shall be determined in the field laboratory and in the presence of the Engineer. Cylinders molded in accordance with AASHTO T 134 shall be cured and tested in compression at 7 days and 28 days. Curing shall be in accordance with AASHTO T 126. Load rate of application shall be in accordance with AASHTO T 22. The minimum compressive strength at 7 days after molding shall be

4 MN/sq.m (40 kg/sq.cm) and the cement content of trial mixes shall be adjusted until this strength is achieved.

1.3 The maximum volume change (swelling) shall be 2% and the maximum loss in weight shall be not more than 8%, when cylinders are molded and tested in accordance with AASHTO T 135, Method B.

1.4 Cement content and water content of the mix on the Site shall each be within -0.2% to +2% of the approved mix design.

2. Plant Mixing Generally

2.1 When cement and granular material are to be mixed in a stationary plant, the plant shall be an approved type pugmill mixing plant of either the batch mix type with revolving blade or rotary drum, or the continuous mixing type. Proportioning of materials and of water may be by either weight or volume.

2.2 Cement shall be added in such a manner that it is uniformly distributed during the mixing operation. Safe, convenient facilities shall be provided for sampling cement in the supply line to the weigh hopper or pugmill.

2.3 Means shall be provided whereby the Engineer may verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water and the points at which it is introduced into the mixer shall be as approved.

2.4 The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all of the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected.

2.5 The moisture content of the completed mixture shall be not more than one per cent below optimum moisture content at the point of delivery to the Works.

3. Batch Mixing

3.1 Batch mixing plants shall be equipped with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

3.2 The mixer platform shall be of ample size to provide safe and convenient access to the mixer and other equipment.

3.3 The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within 2 seconds.

3.4 The time of mixing a batch shall begin after all ingredients are in the mixer and shall end when the mixer is half emptied. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated materials of uniform appearance is produced. The time of mixing shall not be less than 30 seconds. When blending of different sizes is required, the materials shall be blended as they enter the mixer.

3.5 Cement for each batch shall be weighed on scales separate from the aggregate batching scales. Each cement scale graduation shall be approximately 0.001 times the total capacity of the scales. The total capacity shall not be greater than that of commercially available scales when weighing twice the amount of cement required when the plant is operated at full capacity. No scale shall be used with a capacity less than 500 kg.

4. Continuous Mixing

4.1 Continuous mixing plants shall be designed such that granular materials are drawn from the storage facility by feeders which continuously supply the correct amount of granular material in proportion to the cement and so arranged that the proportion of each size can be separately adjusted if more than one size is used. Storage facilities containing fine material shall be equipped with vibrating units which shall vibrate the side walls of the feeder to prevent any hang-up of materials while the plant is operating.

4.2 A control system shall be provided that will automatically close down the plant when the material in any storage facility approaches the strike-off capacity of the feed gate. The plant will not be permitted to operate unless the control system is in proper working order.

4.3 The feeder for the granular material shall be mechanically or electrically driven. Mechanically driven feeders shall be directly connected with the drive on the cement feeder. The drive shaft on the feeder shall be equipped with a revolution counter reading to 0.1 of a revolution. Electrically driven feeders shall be actuated from the same circuit that services the motor driving the cement feeder.

4.4 The cement feeder and the granular material feeders shall be equipped with devices by which the rate of feed can be determined while the plant is in full operation.

5. Mixed in Place Procedures

5.1 Mixed in place procedures will normally be permitted when the granular material to be stabilized is in situ Site material.

5.2 Plant and equipment for pulverizing (if required) and for mixing all materials will be approved on the basis of preliminary trials to establish that such plant and equipment are capable of producing the specified degree of mixing and uniformity of stabilized material for the full thickness of each layer. Single pass or multi-pass equipment may be used.

5.3 The mixing equipment shall be equipped with a device for controlling the depth of processing and the mixing blades shall be maintained or reset periodically so that the correct depth of mixing is obtained at all times. Cement shall be spread ahead of the mixer by means of a cement spreader, fitted with a device to ensure a uniform and controllable rate of spread of cement transversely and longitudinally.

5.4 If multi-pass equipment is utilized, the fine cohesive fraction (if any) of the material shall first be pulverized to the required depth with successive passes and the moisture content adjusted if it is more than 3% below the value required for compaction. Cement shall then be spread and mixing continued with successive passes until the required depth and uniformity have been achieved.

5.5 If it is necessary to adjust the moisture content of the material to the optimum for compaction, water shall be added during the mixing operation using a water sprayer of such design that the water is added in a uniform and controllable manner both transversely and longitudinally.

5.6 The mixing equipment shall be set so that it cuts slightly into the edge of any adjoining completed lane so as to ensure that all material forming the layer has been properly processed. The Engineer may approve the use of scarifiers or preparizers ahead of the mixing equipment. The output of the mixing equipment shall be such that a minimum rate of 20 lin.m/hr measured longitudinally of completed stabilized layer can be maintained in order to permit satisfactory compaction of the mix.

6. Placing of Stationary Plant Mixes

6.1 Immediately prior to depositing the mix, the surface area to be covered shall be moistened and kept moist.

6.2 The cement stabilized mix shall be protected against moisture loss during transporting, by use of suitable covers. The mix shall be deposited on the roadbed at a quantity per lin. m which shall provide the compacted thickness

for the width being spread without resort to spotting, picking up, or otherwise shifting the mixture. Segregation shall be prevented and the mix shall be free from pockets of coarse or fine materials.

6.3 The mix shall be spread in widths of not less than 2 lanes, insofar as the width of surface permits. Longitudinal construction joints shall fall within 300 mm of lane lines. The mix shall be spread by one or more spreaders operating in a staggered position across the subgrade. If traffic conditions require that less than 2 lanes be spread, not more than 2 hours shall elapse between the times of placing the material in adjacent lanes.

6.4 The compacted thickness of any one layer shall not exceed 200 mm and shall be not less than 80 mm. When more than one layer is placed, the surface of the lower layer of compacted mix shall, until covered with the next layer, be kept moist with water or a curing seal as specified.

6.5 In the case of areas inaccessible to mechanical spreading equipment, the mix may be spread in one layer by approved methods only. After spreading, the material shall be thoroughly compacted to the required lines, grades, and cross section by means of pneumatic tampers, or other approved compacting equipment.

6.6 Use of motor graders will not be permitted during spreading or compacting operations. Motor graders may be used only to trim the edges and surface after compaction in order to finish within the specified tolerances.

6.7 A motor grader may be classified as a self-propeled mechanical spreader if it has been equipped with end wings on the blade, has the blade locked in a position perpendicular to the direction of travel, and is equipped with cross slope and automatic grade controls that meet the requirements for the specified type of spreading.

6.8 Each layer of the mix shall be spread in one operation with an approved type self-propeled mechanical spreader such that the layer is made ready for compaction without further shaping. The spreader shall be provided with a fully automatic and adjustable screed that strikes off and distributes the material to the full width being spread and to the surface tolerances specified.

6.9 The spreader shall be equipped with grade sensing controls to automatically control the longitudinal grade and transverse slopes of the screed. Screed action includes any cutting, crowding, or otherwise that produces a finished surface texture of uniform appearance.

6.10 Cement stabilized mixes shall not be mixed or placed while the atmospheric temperature is below 2 degrees C and shall not be placed on

frozen ground. A curing seal as specified shall be applied to the surface of the compacted mix before the atmospheric temperature approaches 2 degrees C.

7. Compaction and Finishing

7.1 Immediately upon completion of spreading or spreading and mixing in place operations, and completion of shaping, the mix shall be initially compacted by one complete coverage using approved type rollers.

7.2 If the finished surface after initial compaction is outside the specified tolerance, all high spots shall be trimmed off to within the specified tolerance. Filling of low areas by drifting or hauling of trimmed material will not be permitted.

7.3 Following trimming, the finished surface shall be finally compacted to not less than 100% of the laboratory density of the approved job mix specimens as determined by AASHTO T 134. Final compaction shall be accomplished in such a manner that no loose material remains on the surface and all tear marks are eliminated.

7.4 The surface tolerances shall conform with the tolerance requirements for granular sub-base. In the case of any areas which are lower than the allowable tolerance, the stabilized layer shall be removed and fresh stabilized mix placed and properly compacted and finished, unless filling of the low areas with bituminous concrete or cement concrete is approved.

7.5 When the superimposed course will be cement concrete, the low areas may, if approved, be filled with concrete at the time and during the same operation that the concrete pavement is placed. Such additional concrete shall be at the Contractor's expense.

7.6 When the superimposed course will be bituminous concrete, the low areas may, if approved, be filled with bituminous concrete to the same standard. This filling shall be carried out as a separate operation prior to placing the bituminous concrete course (unless the thickness to be placed is too small to make this practicable) and shall be at the Contractor's expense.

7.7 Not more than 2 hours shall elapse between the time water is added to the mixed materials and the time of completion of initial compaction. Final compaction shall be completed within 30 minutes of initial compaction.

7.8 At the end of each day's work and when operations are delayed or stopped for more than 2 hours, a vertical construction joint shall be made in the fully compacted layer, perpendicular to the centerline. Additional mix shall not be placed until the construction joint has been approved.

7.9 One hour after the stabilized mix has been finally compacted, vertical longitudinal joints shall be constructed by cutting into the existing edge to a depth of approximately 100 mm. The mix cut away shall be discarded. The face of the cut joints shall be moistened in advance of placing the adjacent lane.

8. Curing

8.1 Curing seal as specified shall be applied uniformly to the completed surface at a rate of between 0.75 and 1.25 ltr/sq.m, as determined by the Engineer. The curing seal shall be applied on the same day that final compaction is performed and as soon as practicable thereafter. The surface shall be kept moist until the seal is applied.

8.2 Damage to the curing seal or stabilized surface shall be promptly repaired by the Contractor at his own expense, in an approved manner.

3.04.6 TESTING OF CEMENT STABILIZED COURSES

1. For every 5,000 sq.m of each stabilized layer or for each day's completed area (whichever is smaller) the following sampling and testing shall be carried out.

1.1 In situ density of a minimum of 3 samples (taken immediately after final compaction) determined in accordance with AASHTO T 191 or T 205 and which shall be not less than 100% of the density of the approved laboratory mix.

1.2 Cement content in accordance with AASHTO T 211.

1.3 Gradation of mix in accordance with AASHTO T 27.

1.4 Moisture - density relationship for mix sampled fresh from the Site, in accordance with AASHTO T 134 if the source of the material is changed.

1.5 Compressive strength of a set of 3 test specimens molded and cured in accordance with AASHTO T 134 and T 126, and tested in accordance with AASHTO T 22.

3.04.7 BITUMEN STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized if specified in the Special Specification shall be a sand, sandy gravel or silty or clayey gravel and sand material with a

P.I. not exceeding 12% and L.L. not exceeding 25% and with not more than 30% passing a 0.075 mm (No. 200) sieve.

1.2 Bitumen-soil mix proportions shall be established by field laboratory trial mixes, carried out in the presence of the Engineer. The compressive strength shall be determined in accordance with AASHTO T 167 and in such a way as to ensure that the optimum composition of the mix is established.

1.3 The laboratory trial mixes, after being air cured for a period of 7 days and tested in accordance with AASHTO T 167, shall have a minimum compressive strength at 25 degrees C, of 2 MN/sq.m (20 kg/sq.cm) and a Marshall stability at 60 degrees C, of 2,000 N (204 kg). The Index of Retained Strength when tested using a Marshall mould shall be not less than 70%.

2. Stationary Plant Mixing

2.1 When approval is given to utilize stationary plant for mixing, whether batch mixing plant or continuous type mixing plant, the plant and equipment and handling and mixing procedures shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the appropriate requirements specified herein for plant mixing of cement stabilized materials.

3. Mixed in Place Procedures

3.1 Approved type multi-pass or approved type purpose-built, single-pass equipment shall be utilized for on Site mixing and placing. Operators shall be trained and fully experienced in the operation of such equipment.

3.2 Multi-pass equipment may consist of suitable bitumen distributor and motor graders or as otherwise approved.

3.3 The process of pulverizing the fine grained cohesive fraction (if any) of the granular material shall be as specified for cement stabilized courses. Bitumen, of the type and grade selected by the Engineer, shall then be applied to the surface using approved type heating and pressure distribution equipment. Emulsified bitumen shall not normally require heating.

3.4 Spreading and mixing of the bitumen and granular or other material shall be carried out as specified for cement stabilized courses.

4. Placing and Spreading Stationary Plant Mixes

4.1 The placing and spreading of stationary plant mixes shall be as specified for cement stabilized courses.

5. Compaction and Finishing

5.1 Compaction of bitumen stabilized courses to 100% of laboratory density of approved job mix specimens, finishing, and provision of longitudinal joints, shall be as specified for cement stabilized courses.

6. Tolerances and Replacement of Unsatisfactory Areas

6.1 Finished surface tolerances and the rectification procedures for any areas which fail to meet such tolerances, shall be as specified for cement stabilized courses.

6.2 In the case of high spots requiring trimming after initial compaction, raking or similar procedures may be required. If the area is unduly damaged or pitted, the stabilized mix shall be removed and replaced with fresh stabilized mix spread and properly compacted and finished.

3.04.8 TESTING OF BITUMEN STABILIZED COURSES

1. For every 5,000 sq.m of each stabilized layer or for each day's completed area (whichever is the smaller) the following sampling and testing shall be carried out.

1.1 In situ density of a minimum of 3 samples (taken immediately after completion of final compaction) determined in accordance with AASHTO T 191 or T 205 and which shall be not less than 100% of the density of the approved laboratory mix:

1.2 Composition of the mix by extraction in accordance with AASHTO T 164.

1.3 Compressive strength in accordance with AASHTO T 167, of samples before compaction.

1.4 Marshall stability in accordance with AASHTO T 245, of samples before compaction.

3.04.9 LIME STABILIZATION PROCEDURES

1. Mix Design

1.1 The material to be stabilized shall be a clayey gravel, clayey sand or lean clay soil with not more than 50% passing 0.425 mm (No. 40) sieve and Plasticity Index greater than 10%.

1.2 The lime content and optimum moisture content shall be determined in the field laboratory and in the presence of the Engineer. Cylinders molded in accordance with AASHTO T 220 shall be cured and tested at 7 days and 28 days. Load rate of application shall be in accordance with AASHTO T 22. The minimum compressive strength at 7 days after molding shall be one MN/sq.m (10 kg/sq.cm).

1.3 Lime content and water content of the mix on Site shall each be within -0.2% to +2.5% of the approved mix design percentages.

2. Safety Precautions

2.1 Special precautions shall be taken when handling quicklime as it will rapidly corrode equipment and can inflict severe skin burns to personnel coming in contact with it.

2.2 Suitable methods for handling quicklime shall be adopted, including fully mechanized or bottom dump handling equipment and protective clothing worn by the operators. Working operations should take into account the wind direction to minimize the dust problem and consequent eye or skin irritation to any personnel in the vicinity.

2.3 When hydrated lime is used, precautions shall also be taken against the effects of prolonged exposure to the skin.

3. Stationary Plant Mixing

3.1 When approval is given to utilize stationary plant for mixing, whether batch mixing plant or continuous type mixing plant, the plant and equipment and handling and mixing procedures shall be as specified for cement stabilization and as specified herein for plant mixing of lime stabilized materials.

4. Mixed in Place Procedures

4.1 Mixed in place procedures will normally be permitted when the soil to be stabilized is in situ site material.

4.2 Spreading and mixing of the lime and soil material shall be carried out as specified for cement stabilized courses.

5. **Placing and Spreading Stationary Plant Mixes**

5.1 The placing and spreading of stationary plant mixes shall be as specified for cement stabilized courses.

6. **Compaction and Finishing**

6.1 Compaction of lime stabilized courses to 100% of laboratory density of approved job mix specimens, finishing and provision of longitudinal joints, shall be as specified for cement stabilized courses with the following modifications:

6.1.1 When quick lime is used, the layer shall not be compacted immediately after spreading the lime, as hydration of the lime will cause damage to the compacted layer. The time within which the compaction shall be completed will be estimated in the laboratory.

6.1.2 Compaction shall not take place after lime hydration. Any lime stabilized material that has been mixed or deposited after lime hydration, shall be removed and replaced with fresh material, mixed and treated as specified.

7 **Tolerances and Replacement of Unsatisfactory Areas**

7.1 Finished surface tolerances and the rectification procedures for any areas which fail to meet such tolerances shall be as specified for cement stabilized courses.

3.04.10 TESTING OF LIME STABILIZED COURSES

1. For every 5,000 sq.m of each stabilized layer or for each day's completed area (whichever is the smaller) the following sampling and testing shall be carried out.

1.1 In situ density of a minimum of 3 samples (taken immediately after completion of final compaction) determined in accordance with AASHTO T 191 or T 205 and which shall be not less than 100% of the density of the approved laboratory mix.

1.2 Lime content in accordance with AASHTO T 232.

1.3 Gradation of mix in accordance with AASHTO T 27.

1.4 If the source of materials changes, the moisture - density relationship in accordance with AASHTO T 134 and gradation of the new mix in accordance with AASHTO T27.

1.5 Compressive strength of a set of 3 test specimens molded and cured in accordance with AASHTO T 134 and T 126, and tested in accordance with AASHTO T 22.

3.04.11 MEASUREMENT

1. Cement Stabilized Course, Bitumen Stabilized Course and Lime Stabilized Course, shall be measured by cu.m of compacted mix furnished, premixed and placed, or mixed in place, compacted, trimmed, jointed, cured, completed and accepted. Measurements shall be of the area and thickness dimensions shown on the Drawings.

2. Measurement shall also be made of the Trial Section in accordance with the length, width and thickness ordered by the Engineer.

PAY ITEM	UNIT OF MEASUREMENT
(1) Cement Stabilized Course	Cubic meter (cu.m)
(2) Bitumen Stabilized Course	Cubic meter (cu.m)
(3) Lime Stabilized Course	Cubic meter (cu.m)

SECTION 4.01 MATERIALS

4.01.1 SCOPE

1. Materials specified for use in the construction of the various bituminous pavement courses may include any or all of the following:

1.1 Coarse and fine mineral aggregates and filler.

1.2 Bitumen products including penetration graded bitumens, cutback bitumens, emulsified bitumens, modified bitumens, and rejuvenating agents for use in bituminous courses and surface treatments.

1.3 Reinforcing grids for reinforcement of bituminous wearing courses.

2. All material sources and the quality of materials proposed for use in the Works shall be approved prior to procuring or processing material from such sources. Inspection, sampling, testing and retesting as necessary, shall be at the Contractor's expense as prescribed in Section 1.05 - "Control of Materials and Standards for Sampling and Testing" and as specified hereunder for specific materials.

3. Storage and handling of all materials shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing". Materials shall be stored on hard, clean surfaces.

4.01.2 AGGREGATE MATERIALS GENERALLY

1. Sources and Production

1.1 Locating sources and manufacture of materials in accordance with the requirements of the Specifications are the responsibility of the Contractor, who shall produce the required aggregates at the rates and in the quantities necessary to complete the Works on time.

1.2 The Contractor shall have satisfied himself as to the location, suitability and quantity of materials available; extent of work necessary to obtain the material available; the work required to open the quarry and to crush, screen and wash (if necessary) the materials; and the length of haul to the Site.

1.3 Prior to starting quarry operations, the Contractor shall obtain written permission from the Authorities or owners concerned.

1.4 Crushing and screening plants shall not be put into operation prior to their approval. If, after any plant is put into operation, it fails to perform as intended, the Contractor shall either rectify the defects in the existing plant to the satisfaction of the Engineer, or shall provide alternative approved plant.

1.5 Approval of the crushing and screening plants and other equipment shall in no way relieve the Contractor of his responsibilities in respect of producing aggregates which conform to the Specifications and in the quantities required for the completion of the Works on time.

2. Stockpiling

2.1 Stockpile areas shall be surveyed prior to stockpiling to establish control points and to obtain a record of existing cross sections for future use in determining stockpile quantities. The areas shall be adequately drained at all times.

2.2 Stockpiling procedures shall not result in degradation or segregation of the stockpiled material, or introduction of foreign materials into the stockpile. Heights of aggregate stockpiles shall not exceed 5 m.

3. Sampling and Testing

3.1 Sampling and testing procedures shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing" and with the following requirements.

3.2 The Contractor shall submit to the Engineer, 30 days prior to the scheduled beginning of crushing and screening operations, a statement of origin and composition of all aggregates proposed for use in the Works.

3.3 In order to ascertain the properties of aggregate materials, the Contractor shall submit for testing and approval, representative samples of all materials intended for incorporation in the Works, prior to starting quarry operations. The representative samples shall be taken by the Contractor in the presence of the Engineer.

3.4 Tests performed by the Contractor shall be utilized in assessing the locations, extent of deposits and quantities of materials which will conform to the Specifications when properly processed. Any special tests that may be required by the Engineer or in the special specification shall be carried out by the Contractor, in his own laboratory, or an outside laboratory, approved by the Engineer. All testing as carried out by the Contractor shall in no way obviate the need for further testing by the Engineer. Approval of specific sources of

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materials shall not be construed as final approval and acceptance of materials from such sources.

3.5 The Contractor may conduct necessary tests in the Field Laboratory in the presence of the Engineer.

3.6 Processed materials shall be tested and approved before being stockpiled on Site or incorporated in the Works and may be inspected and tested at any time by the Engineer during their preparation, storage and use. Questionable materials, awaiting testing and approval, shall not be unloaded and mixed with materials previously approved. If the grading and quality of any materials delivered to the Site do not conform to the grading and quality of the established control samples, the Engineer will reject such materials.

3.7 Samples shall satisfy all specified test requirements. The Contractor shall permit the Engineer to inspect any and all materials used or to be used, at any time during or after their preparation, or while being used during progress of the Works. Unsatisfactory materials, whether in place or not, shall be removed promptly from the Site. The Contractor shall furnish all necessary materials, labor, tools and equipment and transport required by the Engineer for such inspections.

4.01.3 AGGREGATES FOR BITUMINOUS PAVING MIXES

1. Aggregates for use in bituminous base course, binder and wearing courses, levelling course, and macadam and cold mix courses, shall consist of crushed stone.

2. Coarse aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate shall be the fraction of crushed aggregate material passing 4.75 mm (No. 4) sieve. Mineral filler shall be added when the combined grading of coarse and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.

3. The material from hot bins passing the number 40 sieve (0.425mm) when tested in accordance with AASHTO T90 shall be non plastic . In addtion the material from cold bins should not have PI larger than 4 .

4. Aggregates shall not contain gypsum more than 1% and the coarse fraction of the aggregate shall not contain more than :

5% chert and flint for aggregate to be used in the Wearing course.
5% chert and flint for aggregate to be used in the Binder course.

5. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale.

6. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T112.

7. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.

8. The flakiness index and the elongation index test should be conducted in accordance with BS 812, the following are the maximum limits :

Course	Wearing Course	Binder & Asphalt Base
Flakiness Index F.I	25	30
Elongation Index E.I	25	30

9. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

10. Mineral filler shall consist of finely divided mineral matter such as limestone dust if added sperately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or portland cement, conforming to AASHTO M 17.

11. Combined coarse and fine aggregates for bituminous mixes, including mineral filler , when tested in accordance with AASHTO T 27 and T11, shall conform to the gradations shown in Table 4.1.

Table 4.1: Gradation of Aggregates for Bituminous Mixes

Sieve Designation		Binder Course	Wearing Course	Binder Course	Wearing Course
1 1/2"		-	-	-	-
1 "	(25.0mm)	100	100	100	100
3/4"	(19.0mm)	70 - 100	90 - 100	70 - 100	90 - 100
1/2"	(12.5mm)	53 - 90	71 - 90	53 - 90	71 - 90
3/8"	(9.5mm)	40 - 80	56 - 80	40 - 80	56 - 80
No. 4	(4.75mm)	30 - 56	35 - 56	30 - 56	35 - 65
No. 8	(2.36mm)	23 - 38	23 - 38	23 - 49	23 - 49
No.20	(1.18mm)	13 - 27	13 - 27	14 - 43	14 - 43
No.50	(0.300mm)	5 - 17	5 - 17	5 - 19	5 - 19
No.80	(0.150mm)	4 - 14	4 - 14	4 - 15	4 - 15
No.200	(0.075mm)	2 - 8	2 - 8	2 - 8	2 - 8

12. The loss in weight of aggregate after 500 revolutions , when tested in accordance with AASHTO T 96, shall not exceed 35% .

$$\text{Ratio of wear loss} = \frac{\text{Abrasion after 100 revelution}}{\text{Abrasion after 500 revelution}} \text{ less than or equal 25 .}$$

13. When tested for soundness in accordance with AASHTO T104 the coarse aggregate (retained on No.4 sieve) shall not show signs of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulphate test and 12% in the case of the magnesium sulphate test.

14. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved . Scandinavian test shall be carried out and at least 60% of the coarse aggregate surface area shall remain coated with a bitumen film especialy for exposed surfaces other wise anti stripping agent must be added to achivee the required coating .

15. The material shall contain aminimum 50% sand equivalnt . Test sample shall be taken from hot bins .

4.01.4 AGGREGATES FOR SEAL COATS

1. Cover aggregates for bituminous seal coats shall consist of screenings of crushed stone. Aggregate for slurry seals shall consist of crushed stone fines or natural sand blended with not less than 50% crushed stone fines. For heavy duty applications slurry aggregate shall consist of 100% crushed fines. Wadi

gravels shall not be used for seal costs, suitability of suggested crushed ston fines for use in slurry seal shall be demonstrated prior to use .

2. Aggregates shall not contain crystalline or amorphous gypsum (expressed as SO3) more than 1% , and shall not contain more than 5% chert. .

3. Aggregate particles shall be clean, hard, durable and sound. For particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces and 100% by weight shall have one or more fractured faces.

4. Flakiness Index and Elongation Index tested in accordance with BS-812 shall not be exceed 25% for each of flakiness and elongation index . The percentage by weight of clay lumps & friable particles as determined by AASHTO T 112 shall not exceed 3% . Light weight agregate of specific gravity of 2 or less shall not exceed 3% as determined by AASHTO T 113 .

5. If necessary aggregates shall be washed, or processed by any alternative approval method, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

6. Cover aggregates and aggregate for slurry seals, when tested in accordance with AASHTO T 27 and T11, shall conform to the gradations given in Table 4.2.

Table 4.2: **Gradation of Aggregates for Seal Coats**

Sieve Designation (Square openings)	1st Application Grading B	2nd Application Grading C	Slurry Aggregate
25.0mm (1 in.)	100		
19.0mm (3/4 in.)	90 - 100		
12.5mm (1/2 in.)	20 - 55	100	
9.50mm (3/8 in.)	0 - 15	58 - 100	100
4.75mm (No. 3)	0 - 5	10 - 30	90 - 100
2.36mm (No. 4)	-	0 - 10	65 - 90
1.18mm (No. 8)	-	0 - 5	45 - 70
0.60mm (No. 16)	-	-	30 - 50
0.30mm (No. 50)	-	-	18 - 30
0.15mm (No. 100)	-	-	10 - 20
0.07mm (No. 200)	0 - 0.5	0 - 0.5	5 - 15

7. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Test), shall not exceed 35%.

8. When tested for soundness in accordance with AASHTO T 104, the aggregates shall not show signs of disintegration and the loss by weight shall not exceed 10% in the case of the sodium sulphate test or 12% in the case of the magnesium sulphate test.

9. When tested for resistance to stripping in accordance with AASHTO T 182, at least 95% of the aggregate surface area shall remain coated with a bitumen film.

10. The material shall contain aminimum 50% of sand equivelant as determined by AASHTO T 176 .

4.01.5 STABILIZING AGENTS

1. Cement as Stabilizing Agent

1.1 Cement shall be Portland cement Type II, or sulfate resistant cement Type V, in accordance with the Jordanian Cement Specifications.

2. Bitumen as Stabilizing Agent

2.1 Bitumen may include straight run (penetration grade) bitumen; RC cutback bitumen, MC cutback bitumen, or cationic emulsified bitumen, Type SS. Penetration grade, cutback bitumen and emulsified bitumen shall conform with all relevant requirements herein.

2.2 The selection of a suitable bitumen will depend on the properties of the material to be stabilized and shall be subject to laboratory and field trials by the Contractor, under the supervision of the Engineer.

2.3 When the material moisture content is higher than the normal .in-situ value, material must be dried, the use of penetration grade bitumen , viscous cutback bitumen or asphalt emulsion plant mixing of materials shall be appropriate.

2.4 When the natural moisture content of the material is lower than the normal in-situ value, cutback bitumens or emulsified bitumens are appropriate.

3. Lime as Stabilizing Agent

3.1 Hydrated lime (calcium hydroxide) and quicklime (calcium oxide) shall conform to AASHTO M 216 and to Jordanian standard specification. Mixing of different brands of lime or use of lime from different mills will not be permitted.

3.2 Lime slurry shall be a homogeneous pumpable mixture of lime and water. Slurry shall be a premixed material in which the lime solids content shall be not less than 30% by weight.

4.01.6 BITUMEN GENERALLY

1. Type and Grade

1.1 Each bitumen product furnished for use in the Works shall be obtained from the Jordan Petroleum Refinery and shall exhibit uniform characteristics.

1.2 The grade of bitumen may be changed by the Engineer by one grade either side of the specified grade at no extra cost to the Employer. When more than one type or grade is specified under any item, the Engineer will select the type and grade to be used in the Works. Any such change must be approved by the MPWH.

2. Transporting Bitumen

2.1 All transporting of bitumen shall be by conveyances that are free from contamination. Tank cars or tank trucks used for transporting bitumen shall be carefully inspected, drained, and cleaned if necessary, before loading, to prevent contamination of the bitumen from residues of previous loads. Bitumen may also be delivered and transported in metal drums.

2.2 Tank trucks or trailers used to transport bitumen shall be equipped with an approved sampling device which shall be built into the tank or recirculating or discharge line in such a manner that a sample can be drawn during circulation or discharge.

3. Storage of Bitumen

3.1 The Contractor shall provide an adequate storage facility for bitumen, at the site of the mixing plant. This facility should be clean and stable and provided with cover and shelter from excessive temperatures.

3.2 No open fires or smoking shall be allowed in or around the storage facility.

3.3 The storage capacity should be sufficient to maintain a uniform operation while allowing for delayed shipments and time for testing. Different batches of bitumen should be separated, so as to allow for easy identification.

3.4 If the bitumen is delivered to the site in metal drums, on arrival the drums shall be inspected for:

perforations
rusting
melting

other defects that would directly cause pollution or chemical changes to the bitumen.

Any drum(s) showing any of these defects shall be rejected at the discretion of the Engineer.

3.5 The stored bitumen products should be protected from temperatures which may exceed the range of $-5^{0}C$ to $+60^{0}C$ or as required according to flush point test as determined by AASHTO T 48 .

4. Heating of Bitumen

4.1 Heating equipment shall be of an approved type. Any method of agitation or heating that introduces free steam or moisture into the bitumen will not be approved. During the process of its manufacture, conveyance, storage, or construction use, bitumen of whatever type shall not be heated to temperatures more than 10 degrees C above the maximum application temperature specified for the respective type of bitumen nor above 170 degrees C, whichever is the lower. Materials heated in excess of these temperatures will be rejected and shall not be used in the Works.

4.2 Tanks for heating and storage of bitumen shall be capable of heating the material, under effective and positive control at all times, to the specified temperature. The system shall provide uniform heating for the entire contents of the tank. The circulation system shall be of adequate size to insure proper and continuous circulation of the bitumen during the entire operating period. Suitable means shall be provided, either by steam or oil jacketing, or other insulation, for maintaining the required temperature of bitumen, weigh buckets, spray bars, and other containers.

4.3 Thermometers of approved type and adequate range (calibrated in 2 degrees C increments) for accurately measuring the temperature of the bitumen while heating, shall be located so as to be readily visible and shall be kept clean and in proper working order at all times.

4.4 Where storage tanks are required, their capacity shall be sufficient for at least one day's production.

4.5 Bitumen materials, wasted through careless handling or rendered unsuitable for use by overheating shall not be used in the Works.

5. Sampling and Testing

5.1 Procedures for sampling of bituminous materials shall conform to AASHTO T 40.

5.2 General requirements and procedures for sampling and testing of the various types of bitumen shall conform with the requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing".

5.3 Testing for conformity of bitumen products to AASHTO and other specified standards shall, unless otherwise directed, be performed at the refinery laboratories of the Jordan Petroleum Company.

4.01.7 BITUMEN PRODUCTS

1. Penetration Graded Bitumen

1.1 The various grades of penetration graded bitumen Asphalt cement shall conform generally with the requirements of AASHTO M 20, or with the Specification of the Jordan standard specification Co. Ltd as given in Table 4.3 .

Table 4.3: PROPERTIES OF PENETRATION GRADE BITUMEN

	Penetration Grade					
	40 - 50		60 - 70		80 - 100	
	Min	Max	Min	Max	Min	Max
Ductility at 25°C (cm)	100	-	100	-	100	-
Penetration at 25°C (0.1mm)	40	50	60	70	80	100
Softening Point (°C)	50	58	48	56	45.8	48
Specific Gravity at 25°C	1.01	1.06	1.01	1.06	1.0	-
Loss on heating to 163°C (% wt)	-	1.0	-	1.0	-	1.0
Penetration of residue % of original	75	-	75	-	75	-
Solubility in Trichloroethylene (% wt)	99	-	99	-	99.5	-
Ash content % wt	-	1.0	-	1.0	-	1.0
Flashpoint (Cleveland Open Cup.) (°C)	250	-	250	-	225	-

1.2 If its required in special specification to use viscosity graded asphalt cement it shall meet the requirement of AASHTO M 226-80 table 1,2 .

1.3 Sampling and testing shall be in accordance with the AASHTO standard method listed in AASHTO M 20 .

1.4 Penetration bitumen application temperature range shall be so that appropriate viscosity range for each application is achieved . If however the viscosity curve are not available the valuse given in table 4.4 shall be generally consider as aguidance .

Table 4.4: BITUMEN GRADE

	40/50	60/70	80/100
Application Temperature C	150-170	145-165	140-160

2. Bitumen Modifier

2.1 An approved modifier shall be incorporated in all penetration graded bitumens whenever specified immediately prior to the time of use, unless otherwise shown on the Drawings . The modifier (catalyst) shall serve to polymerize the bitumen by converting the benzylic carbon groups into ketones.

2.2 The modified bitumen shall demonstrate significantly reduced temperature susceptibility and/or improved adhesive qualities. The workability of the modified bitumen shall be unchanged from that of unmodified bitumen.

2.3 The mixing and perparation of Modified Bitumen shall be carried out in accordance with the manufacturers instructions, and with the approval of the Engineer.

3. Rapid-Curing (RC) Cutback Bitumen

3.1 RC cutback shall conform with the requirements of AASHTO M 81, which covers Grades RC-70, RC-250, RC-800, and RC-3000 and are listed in Table 4.5.

Table 4.5: PROPERTIES OF R.C. CUTBACK BITUMEN

	RC-70		RC-250		RC-800		RC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60 °C centistokes	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open-cup), degrees °C	-	-	27	-	27	-	27	-
Water, percent	-	0.2	-	0.2	-	0.2	-	0.2
Distillation test:								
Distillate, percentage by volume of total distillate to 360 °C								
to 190 °C	10	-	-	-	-	-	-	-
to 225 °C	50	-	35	-	15	-	-	-
to 260 °C	70	-	60	-	45	-	25	-
to 315 °C	85	-	80	-	75	-	70	-
Residue from distillation to 360 °C volume percentage of sample by difference	55	-	65	-	75	-	80	-
Tests on residue from distillation:								
Absolute viscosity at 60 °C poises	600	2400	600	2400	600	2400	600	2400
Ductility, 5 cm/min. at 25 °C cm	100	-	100	-	100	-	100	-
Solubility in Trichloroethylene, percent	99.	-	99.	-	99.	-	99.	-
Spot test with:								
Standard naphtha	Negative for all grades							
Naphtha-xylene solvent, - percent xylene	Negative for all grades							
Heptane-xylene solvent, - percent xylene	Negative for all grades							

3.2 Sampling and testing shall be in accordance with the AASHTO standard methods listed in AASHTO M 81.

3.3 RC cutback bitumen spraying temperature ranges shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available the values given below should be generaly consider as guidance :

RC Cutback Grade	Spraying Temp °C
RC - 70	40 - 75
RC - 250	65 - 105
RC - 800	90 - 115
RC - 3000	105 - 135

4. **Medium-Curing (MC) Cutback Bitumen**

4.1 MC cutback shall conform with the requirements of AASHTO M 82, which covers Grades MC-30, MC-70, MC-250, MC-800 and MC-3000 and are listed in Table 4.6.

Table 4.6: PROPERTIES OF M.C. CUTBACK BITUMEN

	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60 °C centistokes.	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open-cup), degrees °C.	38	-	38	-	66	-	66	-	66	-
Water, percent	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2
Distillation test:										
Distillate percentage by volume of total distillate to 360 °C										
to 225 °C	-	25	0	20	0	10	-	-	-	-
to 260 °C	40	70	20	60	15	55	0	35	0	15
to 315 °C	75	93	65	90	60	87	45	66	13	75
Residue from distillation to 360 °C volume percentage of sample by difference.	50	-	55	-	67	-	75	-	80	-
Tests on residue from distillation:										
Absolute viscosity at 60 °C poises	300	1200	300	1200	300	1200	300	1200	300	1200
Ductility, 5 cm/min., cm	100	-	100	-	100	-	100	-	100	-
Solubility in Trichloroethylene, percent	99.	-	99.	-	99.	-	99.	-	99.	-
Spot test with:										
Standard naphtha	Negative for all grades									
Naphtha-xylene solvent, - percent xylene	Negative for all grades									
Heptane-xylene solvent, - percent xylene	Negative for all grades									

4.2 Sampling and testing shall be in accordance with the AASHTO standard methods listed in AASHTO M 82.

4.3 MC cutback bitumen spraying temperature ranges shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available the values given below should be generaly consider as guidance :

MC Cutback Grade	Spraying Temp ^{o}C
MC - 30	21 - 63
MC - 70	45 - 80
MC - 250	70 - 110
MC - 800	95 - 125
MC - 3000	110 - 145

5. Slow-Curing (SC) Cutback Bitumen

5.1 SC cutback shall conform with the requirements of ASTM D 2026 which covers Grades SC-70, SC-250, SC-800, and SC-3000, and are shown in Table 4.7.

Table 4.7: PROPERTIES OF S.C. CUTBACK BITUMEN

	SC-70		SC-250		SC-800		SC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinmatic viscosity at 60°F cSt	70	140	250	500	800	1600	3000	6000
Flash point (Cleveland open cup), C	66	-	79	-	93	-	107	-
Distillation test:								
Total distilate to 360C, volume %	10	30	4	20	2	12	-	5
Solubility in trichlorethylene %	99.	-	99.	-	99.	-	99.	-
Kinmatic viscosity on distillation residue at 60C, St	4	70	8	100	20	160	40	350
Asphalt residue:								
Residue of 100 penetraion, %	50	-	60	-	70	-	80	-
Ductility of 100 penetration residue at 25C, onWater, %	100	-	100	-	100	-	100	-
	-	0.5	-	0.5	-	0.5	-	0.5

5.2 Sampling and testing shall be in accordance with the appropriate ASTM standard methods.

5.3 SC cutback bitumen spraying temperature ranges shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available the values given below should be generaly consider as guidance

SC Cutback Grade	Spraying Temp ^{0}C
SC - 70	45 - 80
SC - 250	70 - 110
SC - 800	95 - 125
SC - 3000	110 - 145

6. Emulsified Bitumens Generally

6.1 Selection and use of emulsified bitumens shall generally be in accordance with the recommendations in AASHTO R 5, subject to the following requirements.

6.2 Emulsified bitumens which have been subjected to freezing temperature while in storage shall be retested and acceptance or rejection of the material shall be based on the results of the retest.

6.3 The manufacturer shall furnish samples of the base bitumen used in the emulsion.

6.4 When samples of undiluted emulsion are not readily available for test purposes, tests may be made on the diluted emulsion and the respective specifications modified to reflect the changes in properties resulting from dilution of the bitumen.

6.5 All emulsified bitumens shall adhere firmly to the surface of the mineral aggregate or the highway surface as appropriate. Failure of the emulsified bitumen to perform satisfactorily on the job shall be deemed cause for its rejection regardless of satisfactory laboratory test results.

7. Anionic Emulsified Bitumen

7.1 Anionic emulsified bitumens shall, prior to dilution, conform with the requirements of AASHTO M 140, for Types SS-1 and SS-1h and as listed in Table 4.8.

4.8: PROPERTIES OF ANIONIC EMULSIFIED BITUMEN

	Slow-Setting			
	SS-1		SS-1h	
	Min.	Max.	Min.	Max.
ts on emulsions:				
scosity, Saybolt Furol at 25C, s	20	100	20	100
scosity, Saybolt Furol at 50C, s	-	-	-	-
orage stability test, 1-h, %	-	1	-	1
ment mixing test, %	-	2.0	-	2.0
ieve test, %	-	0.1	-	0.1
esidue by distillation, %	57	-	57	-
sts on residue from stillation test:				
enetration, 25C, 100 g, 5 s	100	200	40	90
uctibility, 25C 5 cm/min, cm	40	-	40	-
Solubility in trichloro-ethylene %	97.5	-	97.5	-

f type of emulsion is not specified in the special tecnical pecification slow setting shall be used .

.2 Sampling and testing shall be in accordance with AASHTO T 59.

.3 Emulsified bitumen spraying temperature range shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available these values should be generaly consider as guidance 25 - 65 degrees C (except for Grade RS-2 where the range shall be 50-75 degrees C). The temperature range for pugmill mixing for medium and slow setting types shall be 15-65 degrees C.

8. Cationic Emulsified Bitumen

8.1 Cationic emulsified bitumens shall, prior to dilution , conform with the requirements of AASHTO M 208, for Types CSS-1 and as listed in Table 4.9.

Table 4.9: PROTECTION OF CATIONIC EMULSIFIED BITUMEN

	Slow-Setting CCS-1	
	Min.	Max.
Tests on emulsions:		
Viscosity, Saybolt Furol at 25C, s	200	100
Storage stability test, 24-h, %		1
Particle charge test	Positive	
Sieve test, %		0.10
Cement mixing test, %		2.0
Distillation:		
Residue, %	57	
Tests on residue from distillation test:		
Penetration, 25C, 100 g, 5 s	100	250
Ductibility, 25C, 5 cm/min, cm	40	
Solubility in trichloroethylene %	97.5	

If type of emulsion is not specified in the special tecnical specification slow setting shall be used .

8.2 Sampling and testing shall be in accordance with AASHTO T 59.

8.3 Emulsified bitumen spraying temperature range shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available these values should be genaraly consider as guidance 25-65 degrees C (except for Grade CRS-2 where the range shall be 50-75 degrees C). The temperature range for pugmill mixing for medium and slow setting types shall be 15-65 degrees C.

9. Reinforcing Grids

9.1 Grid reinforcement for bituminous wearing courses, when shown on the Drawings, shall consist of approved type, high strength polymer (polypropylene) grid matting, with rectangular-shaped openings, and furnished in rolls of at least 50 m single lengths.

9.2 The reinforcing grid shall be non-corrodible, temperature stable up to at least 160 degrees C and exhibit a minimum tensile strength, longitudinally and transversely, of 0.010 MN/m at 8% strain.

4.01.8 MEASUREMENT

1. Granular Material, Base Course Aggregate, Aggregates for Bituminous Seal Coats and for Bituminous Mixes, Modified (Penetration Graded) Bitumen, Straight Run (Penetration Graded) Bitumen, Cutback Bitumen, Emulsified Bitumen, Portland Cement, Lime, and Reinforcing Grid, shall be measured as prescribed in the appropriate Sections of these Specifications.

SECTION 4.02: BITUMINOUS PRIME AND TACK COATS

4.02.1 SCOPE

1. These Works shall consist of furnishing and applying MC cutback bitumen prime coat to a previously constructed subgrade, sub-base or aggregate base course, highway shoulders, or concrete pavement; and furnishing and applying RC cutback bitumen or emulsified bitumen as a tack coat to a previously constructed bituminous base or wearing surface to provide bond for a superimposed bituminous course; all as and where shown on the Drawings.

4.02.2 MATERIALS

1. Medium-Curing Cutback Bitumen

1.1 MC cutback bitumen (for prime coats) shall be as recommended by ASTM D2399-83 for open and tight surfaces however if not specified in the special technical specification MC-70 as specified in section 4.01 (material) shall be used .

2. Rapid-Curing Cutback Bitumen

2.1 RC cutback bitumen (for tack coats) shall be Grades RC-70 or RC-250 as appropriate and as specified in Section 4.01 - "Materials" or as required in the Special Specification.

3. Slow-Curing Emulsified Bitumen

3.1 Slow-setting emulsified bitumen (for tack coats) shall be slow-setting Grades SS-1, SS-1h, CSS-1, or CSS-1h, as appropriate and as specified in Section 4.01 - "Materials", or as required by the Engineer.

4.02.3 EQUIPMENT

1. Equipment used for diluting emulsified bitumen, heating cutback bitumen, spraying cutback and emulsified bitumen, and for application of blotting material to prime coats, shall conform with the requirements of Section 1.12 - "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

4.02.4 CONSTRUCTION OF TRIAL SECTIONS

1. The Engineer may, if he deems necessary, require trial sections to be constructed prior to the commencement of on Site prime or tack coat applications. The Contractor shall construct trial sections using varying application rates of bitumen, as selected by the Engineer. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site.

2. Each trial section shall be constructed using the same materials, mixing and spraying equipment, and construction procedures, proposed for use in the Works.

3. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment and the most suitable application rates for cutback bitumen prime and tack coats.

4. The Contractor shall not proceed with any site coat applications until the methods and procedures established in the trials have been approved.

4.02.5 APPLICATION PROCEDURES

1. General

1.1 All equipment used for surface cleaning, heating bitumen (if required) and application of prime and tack coats, shall be adequate for the purposes intended and shall be approved before use.

1.2 All surfaces to receive prime or tack coats shall conform with the specified tolerances and compaction requirements and shall be properly cleaned using power brooms or power blowers. The surfaces shall be approved before applying any bitumen material.

1.3 Application of prime coats and tack coats shall be performed only when the surface to be treated is sufficiently dry, for tack coat and sufficiently moist for prime coat, and when the atmospheric temperature is above $10^{o}C$ for the application of tack coat, $15^{o}C$ for the application of prime coat. There should be no fog, rain, strong winds, dusty conditions, or dust storms.

1.4 The surfaces of all structures, curbs, gutters and other highway appurtenances shall be protected in an approved manner to prevent them from being splattered or stained with bitumen or damaged during equipment operation. The Contractor shall be responsible for making good any such staining or damage to the satisfaction of the Engineer.

1.5 Traffic shall not be permitted on surfaces after they have been cleaned and prepared for prime or tack coat application.

1.6 If there are undue delays in scheduling priming or subsequent paving after priming, the surface tolerances and compaction of the granular course shall be reverified and deficient areas corrected or replaced in an approved manner at the Contractor's expense.

1.7 The Contractor shall maintain prime coats and tack coats intact until they are covered by the subsequent pavement course. Any area where the coats have been damaged shall be cleaned of all loose material, any surface defects repaired and the coat re-applied at the Contractor's expense. Traffic control measures shall conform with the relevant requirements of Section 8.10 - "Maintenance of Traffic and Detours".

2. Prime Coat Application

2.1 If required by the Engineer, when the surface is an untreated subgrade or a granular surface, the cleaned surface shall be given a light application of water and allowed to dry to the condition deemed appropriate by the Engineer before the bituminous material is applied.

2.2 Heating of MC cutback bitumen and its temperature at the time of application shall conform with the relevant requirements of Section 4.01 - "Materials".

2.3 Areas to be primed shall be as shown on the Drawings and including 200 mm widths outside the edges of the pavement line; top of embankment slopes to pavement lines; and between curbs or gutter edges for bridge checks.

2.4 Application rates for prime coat will be determined by the Engineer from the trial sections, and shall be generally within the following ranges:

Range of Application Rates for Prime Coat

Type of Surface	ltr/sq.m
Untreated subgrade surfaces, shoulders sub-base and base courses	0.75 - 2.0
Other surfaces (determined from field tests or trials)	

2.5 The Engineer may order additional trial sections and/or alter the previously established rates of application during progress of the Works.

2.6 Prime coat (MC-70) cutback, or other grade if ordered by the Engineer, shall be applied at the rate selected by the Engineer, using approved type pressure distributors operated by skilled workmen. The spray nozzles and spray bar shall be adjusted and frequently checked so that uniform distribution is ensured. Spraying shall cease immediately upon any clogging or interference of any nozzle, and corrective measures taken before spraying is resumed.

2.7 Hand spraying will be approved only for priming small patches or inaccessible areas that cannot be primed by normal operation of the pressure distributor.

2.8 Application of prime at the junction of spreads shall not be excessive. Any excess shall be removed from the surface and any skipped areas or recognized deficiencies shall be corrected by use of hand sprays.

2.9 When required by the Engineer, a light covering of blotting material shall be applied to the prime coat 48 hours after spraying and when it has not dried sufficiently to withstand damage by traffic. The blotting material shall be a smooth fine sand, or other approved material.

2.10 Prime coats shall be cured for 3 days before traffic is allowed on it or before the succeeding pavement layer is placed, or as directed by the Engineer.

3. Tack Coat Application

3.1 Tack coat application shall be (as shown on the Drawings) on clean dry surface and the rate shall be as ordered by the Engineer. Emulsified bitumen shall be diluted and thoroughly mixed with an equal amount of water before application.

3.2 Heating of RC cutback bitumen and its temperature at the time of application shall conform with the relevant requirements of Section 4.03 "Bituminous Prime and Tack Coats". Where slow-curing emulsified bitumen (SS or CSS Type) is used for tack coat, it shall not normally require heating except in temperatures below 20 degrees C.

3.3 The rate of application shall be approved by the Engineer and after trial tests are carried out it shall be between 0.1 and 0.6 kg./sqm. depending on wether RC cutback or emulsified bitumen is used and the surface condition of the bituminous course on which the tack coat is to be sprayed. The Engineer may alter the previously established rates of application during progress of the Works, if he deems it necessary.

3.4 The tack coat shall be allowed to dry only until it is in a suitable tacky condition to receive the superimposed bituminous course. Tack coat application shall not proceed so far in advance of the following course that it dries out completely.

3.5 Spraying procedures shall be as specified for prime coat application.

3.6 Blotting material shall not be applied to tack coats.

4.02.6 MEASUREMENT

1. Bituminous Prime Coat shall be measured by the liter (or ton) o bituminous material of each type furnished, applied, completed and accepted Measurement shall be of the material before heating and shall be as per rat chosen from the Trial Sections.

2. Bituminous Tack Coat shall be measured by the liter (or ton) o bituminous material of each type furnished, applied, completed and accepted.

3. Surface preparation, protective measures to avoid staining or damage t appurtenances, blotting of prime coats when required, and cleaning stains an repairing damage caused by equipment, etc shall not be measured for direc payment, but shall be considered as subsidiary Works the costs of which will b deemed to be included in the Contract prices for the Pay Items.

	PAY ITEM	UNIT OF MEASUREMENT
(1)	Bituminous Prime Coat	ton
(2)	Bituminous Tack Coat	ton

SECTION 4.03: BITUMINOUS COURSES

4.03.1 SCOPE

1. These Works shall consist of the general requirements for furnishing materials, mixing at a central mixing plant, and spreading and compacting various bituminous concrete and other bituminous mixes, including installation of reinforcing fabric when specified, all as and where shown on the Drawings.

2. Requirements with particular application to bituminous base course, binder and wearing courses, leveling course, macadam course, cold mix courses, or recycled bituminous base course, are specified in the respective Sections relating to such courses.

3. In the case of any conflict or ambiguity between the particular bituminous course Sections of these Specifications and this Section, the requirements of the particular Sections shall prevail.

4.03.2 MATERIALS

1. Bituminous plant mixes shall generally be composed of coarse mineral aggregate, fine mineral aggregate, mineral filler or cement if required, and penetration graded bitumen with mix additives if specified, cutback bitumen or emulsified bitumen appropriate to the type of bituminous course to be constructed.

2. All materials shall conform with the relevant requirements of Section 4.01 - "Materials".

4.03.3 JOB MIXES AND PROJECT MIXES

1. At least 30 days prior to the date the Contractor intends to begin production at the mixing plant and after receiving approval of the aggregates, and after the delivery to the Site of the bitumen specified, the Contractor shall submit for approval his proposed Job Mix Formula. Therefore sample from materials use in preparing mix design (aggregates abd bitumen) shall be sent to the clients laboratories to be tested for final approval of the mix design .

2. The Job Mix Formula shall stipulate a single combined grading of all aggregate and filler materials showing the specific % by weight passing each sieve size and the specific % by weight of each material to be used in the total mix.

3. The Job Mix Formula shall be established by the Contractor, under the supervision of the Engineer, in the field laboratory. Mix design procedures shall conform with the Marshall method of mix design and relevant procedures contained in Asphalt Institute Manual MS-2. All trial mixes shall be prepared and tested by the Contractor in the presence of the Engineer.

4. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen (plus bitumen modifier if any) in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen content ranges and which meets the Marshall test requirements, as prescribed for each particular type of bitumen course. It shall also stipulate the mixing temperature at discharge from the mixer which, unless otherwise directed, shall be 170 degrees C.

5. The Marshall test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.

6. When compacting specimens in accordance with the Marshall test procedure, the number of blows applied with the compaction hammer shall be 75 on each side, unless otherwise specified.

7. In order to meet the requirements, an approved additive such as portland cement, hydrated lime or liquid antistrip agent, may be required in the Job Mix. Portland cement shall meet the requirements of AASHTO M 85. Hydrated lime shall meet the requirements of ASTM C 207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid antistriping agent, if needed will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers specifications.

8. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in Table 4.10 with respect to the Job Mix gradations:

Table 4.10: MAXIMUM VARIATIONS OF PROJECT MIX FROM APPROVED JOB MIX

Sieve Designation (square openings)	Specified Tolerances
9.5 mm (3/8 in.) and above	+ or - 5.0%
4.75 mm (No. 4)	+ or - 4.0%
2.36 mm (No. 8)	+ or - 4.0%
1.18 mm (No. 16)	+ or - 4.0%
0.600 mm (No. 30)	+ or - 4.0%
0.300 mm (No. 50)	+ or - 4.0%
0.150 mm (No. 100)	+ or - 4.0%
0.075 mm (No. 200)	+ or - 1.5%
Bitumen Content	+ or - 0.3%
Temperature of Mix on discharge	+ or - 5°C of the specified mixing temperature

9. Any deviation from these limits shall be made only with the approval of the Engineer, unless it is allowed for in the Special Specifications.

10. Conformance to gradation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance with AASHTO T 164.

11. The Engineer will test the project mix at least twice daily during plant operation and, if necessary, direct the Contractor to readjust the plant to conform to the Job Mix Formula. If, due to differing cold feed or hot bin gradations, the Contractor cannot consistently produce a project mix meeting the Job Mix requirements, production shall cease, the Job Mix shall be redesigned and reapproved and the plant readjusted to produce a new Job Mix.

12. The participation of the Engineer in the preparation of the Job Mix Formula shall in no way relieve the Contractor of responsibility for producing project mixes meeting the specified requirements.

4.03.4 EQUIPMENT

1. General

1.1 Plant and equipment for mixing, transporting, spreading and compacting bituminous mixes, shall conform with the requirements of Section 1.12 -

"Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

2. **Mixing Plant**

2.1 Bituminous mixes shall be produced in an approved type batch mixing plant of adequate size with a minimum capacity of not less than 80 ton/hr and a mixer capacity of not less than 750 kg batch. The plant shall conform with the relevant requirements of AASHTO M 156.

2.2 A mechanical batch counter shall be installed as part of the timing device and shall be designed to register only completely mixed batches.

2.3 The mixing plant shall be fully equipped to control the gradation of hot dry aggregates and of cold damp aggregates. A suitable dust collection system shall be installed, capable of returning all dust to the mixture whenever required. Suitable filters shall be incorporated whenever the mixing plant is in the vicinity of town, or whenever they are required by law. The plant should be equipped with seperate bin for mineral filler material .

2.4 The cold feed system shall be of continuous belt feed type or other approved system. It should be easily modified to allow hydrated lime slurry to be added to the mix prior to heating, and dry powdered lime added after heating.

2.5 An approved type automatic weighing, cycling and monitoring system shall be installed as part of the batching equipment. Facilities for easy sampling of the aggregates from the hot bins whilst the plant is in operation and shall also be provided.

2.6 The use of a continuous mixing plant will only be considered in special circumstances. In such cases, if the Contractor proposes to use a continuous mixing plant for all or part of the bituminous mixing, full details of the plant including its in-service record if not new and the manufacturer's specifications, shall be submitted for approval before proceeding with the purchase or delivery to Site of such plant.

2.7 The Contractor shall systematically inspect and verify, in the presence of the Engineer, on a weekly basis and also whenever suspect, the following key operational aspects of the mixing plant:

2.7.1 State of repair of the screens, and their frame mountings

2.7.2 Proper working of cold and hot bin gates

2.7.3 Accuracy of batching scales for filler, aggregates and bitumen.

2.7.4 Proper working of the nozzles of the mixer bitumen sprayer

2.7.5 State of repair of the paddle tips and liners of the mixer

2.7.6 Thermometers in working conditions .

2.8 The Contractor shall furnish, for reference and retention by the Engineer, one complete set of the manufacturer's instruction and operating manuals for the mixing plant intended for use.

2.9 At the commencement of the Contract at least one copy of the ASTM and AASHTO (applicable copies) latest edition and 3 copies each of the latest editions of Asphalt Institute Specification SS-1 and Manuals MS-2, MS-3, MS-8 and MS-22 shall be furnished by the Contractor for use by the Engineer's supervisory staff and, in addition, one copy of each as appropriate shall be issued to each of the Contractor's senior staff involved in bituminous course Works. At the end of the Contract all the copies shall become the property of the Ministry.

3. Spreading and Finishing Equipment

3.1 Bituminous courses shall be spread and finished using approved type, self-contained, power-propelled pavers of sufficient capacity to be capable of laying up to 80 ton/hr. Pavers shall be provided with electronically controlled vibratory screed or strike-off assembly with devices for heating the screed, and shall be capable of spreading and finishing the various courses of bituminous plant mix to the proper thickness and in lane and shoulder widths applicable to the typical cross sections shown on the Drawings, and in incremental widths down to 2.4 m minimum and up to 8 m maximum.

3.2 The pavers shall employ mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices, to maintain trueness of grade and confine the edges of the mix to true lines without the use of stationary side forms. Joint leveling devices shall be provided for smoothing and adjusting longitudinal joints between lanes.

3.3 The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mix uniformly in front of the full length of the screed.

3.4 The screed or strike-off assembly and extensions shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mix.

3.5 The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mix. Speed shall be fully adjustable between 3 m/min and 6 m/min.

3.6 The automatic controls shall consist of an automatic linkage arrangement such that, through the process of automatically adjusting the screed thickness control, the mix can be placed and finished to a predetermined grade and a uniform crown or cross section. Articulated averaging beams shall be at least 9 m in length.

3.7 If during construction, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by scheduled operations, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.

3.8 The Contractor shall make available, for reference by the Engineer, the manufacturer's instruction and operating manuals for each paver intended for use.

4.03.5 CONSTRUCTION OF TRIAL SECTIONS

1. Immediately prior to finalization of the Job Mix Formula, the Contractor shall lay trial sections of the various bituminous mixes intended for use in the Works. Each trial section shall be 2 lanes wide by 50 m long at approved locations close to the Site. Each trial section shall be laid using the same materials, proposed Job Mix, mixing, spreading and compaction plant and spreading and compaction procedures, proposed for use in the Works.

2. Each trial section shall serve as a field verification of the Job Mix design. The mix density achievable and the air voids at that density shall be determined and, if less than required, the Job Mix Formula shall be adjusted accordingly.

3. Each trial section shall also demonstrate the adequacy of hauling, spreading and compaction equipment and the suitability of the construction methods and organization proposed.

4. If the trial section meets the required specification, the Job Mix Formula will be approved.

5. The trial section shall be carried out at the Contractor's expense and is to be removed from Site, if required by the Engineer.

4.03.6 MIXING PROCEDURES

1. Each aggregate ingredient shall be heated and dried such that the temperature recorded in the hot fines bin after screening shall not exceed 170 degrees C. If any aggregates contain excess moisture so as to cause foaming in the mixture or their temperature is in excess of 170 degrees C, they shall be removed from the bins and disposed of as directed.

2. Immediately after heating, the aggregates shall be screened into at least 3 sizes and conveyed into separate bins ready for batching and mixing with the bitumen. When the aggregates furnished are of such size and grading that separating into 3 bins is impractical, the number of required separations may, if approved, be reduced to 2 only. Screening operations shall produce, at plant operating capacity, gradations in each of the sizes of heated and dried aggregates that are reasonably uniform and will result in the production of a mix conforming to the Job Mix requirements.

3. The dried and heated aggregate and (cold) mineral filler shall be combined in the plant in the proportionate amounts as determined by the Job Mix. Just prior to bitumen entering the mixer, bitumen modifier (catalyst) or antistripping additive, if required, shall be thoroughly mixed with the bitumen which shall then be introduced into the pugmill mixer in the proportionate amount determined by the Job Mix.

4. The temperature of the bitumen upon entering the pugmill shall be within 15°C of the aggregate temperature. Unless otherwise directed, the bitumen temperature shall be as given in Table 4.11.

Table 4.11:

Type and Grade of Asphalt	Viscosity (centistokes)	Max. Temperature °C Immediately after discharge from Pugmill
85 - 100 pen.	170 ± 20	160
60 - 70 pen.	170 ± 20	163
40 - 50 pen.	170 ± 20	170

5. Any mix subjected to higher temperature than those shown in Table 4.11 shall be rejected.

6. The mixing time required in order to obtain a homogeneous mix and adequate coating of the aggregates with bitumen shall be determined by the

Contractor in the presence of the Engineer. This time shall be determined whenever the source of aggregate for the mix changes.

7. In batch plants, mixing time shall begin upon entry of bitumen into the pugmill.

8. Mixing time for continuous mixing plants will be determined by the following formula or other approved methods:

Mixing time (sec) = Pugmill dead capacity (kg) divided by pugmill output (kg/sec)

4.03.7 SURFACE PREPARATION

1. When the bituminous mix is to be placed on a prepared subgrade, subbase, or base, the surface shall be prepared to meet the appropriate specified compaction and surface tolerance requirements. The surface shall then be primed as specified in Section 4.02 - "Bituminous Prime and Tack Coats". No bituminous mix shall be laid on a prime coat until it has been inspected and approved.

2. When the bituminous mix is to be placed on an existing bituminous surface, the surface shall be cleaned of all foreign material and broomed free of dust. Any loose, broken or shattered bituminous material along the edges of the existing surface shall be removed and the exposed subgrade, and a sufficient width of the shoulder adjacent to the edge of the existing surface, shall be shaped, bladed, compacted and broomed to provide a uniform firm subgrade for the new surface course.

3. Broken, soft, or unstable areas of existing bituminous surface, base or subgrade shall be removed and replaced. The areas shall be excavated to a depth as directed and refilled with the specified bituminous mix.

4. Prior to placing of the bituminous mix on an existing bituminous surface when required, a tack coat as specified in Section 4.02 - "Bituminous Prime and Tack Coats" shall be applied to the existing surface at the rate determined by the Engineer. No mixture shall be laid on a tack coat until it has been inspected and approved.

4.03.8 DELIVERY, SPREADING AND FINISHING

1. Delivery of Mix to Site

1.1 A sufficient number of haul vehicles shall be provided so that adequate supplies of mix are delivered to ensure that continuous paving will be achieved.

1.2 Hauling equipment for aggregates and bituminous mixes shall consist of vehicles having dump bodies suitable for dumping materials in a windrow or in spreader boxes. The bodies shall be so constructed that their volume measurement can be accurately determined. They shall be constructed and maintained such that loss of materials during hauling operations will not occur. Dump controls shall be capable of operation from the driver's seat.

1.3 Hauling equipment for hot bituminous mixes shall have tight, clean, smooth metal beds which are periodically thinly coated with a lime solution or other approved material to prevent adherence of the mix. All hauling units shall be equipped with a canvas or other approved type cover which shall be used to cover the hot material upon loading at the mixing plant and shall not be removed until the mix is discharged into the paver.

1.4 The dispatching of the hauling vehicles to the Site shall be so scheduled that all material delivered is placed at least 90 minutes before sunset to allow sufficient time for compaction, unless the use of artificial light is approved. Delivery of material shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

1.5 The mix at delivery to the paver shall be not more than $10^{o}C$ below discharge temperature at the mixing plant. The minimum temperature for the commencement of breakdown rolling is $120^{o}C$. Mix loads of temperature less than $120^{o}C$ shall not be accepted, and the load shall be disposed of and another load used. If there is consistent failure to meet the temperature requirement the Engineer shall order paving operations to stop until suitable measures are taken by the Contractor to ensure that temperature requirements are met.

1.6 Each haul vehicle shall be weighed after each loading at the mixing plant and accurate records shall be kept of the gross weight and net weight of each load, for each vehicle and dates and time of loading.

2. Setting Out and Reference Lines

2.1 The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval. A reference line of wire or suitable cord shall be installed at a uniform grade parallel to the approved reference grade line such that conformance with the required geometrics, surface tolerance and minimum thickness requirements shall be ensured. The reference line shall be supported at 8 m maximum spacing unless there is noticeable sag in the line or the pavement surface, in which case the maximum spacing shall be 4 m.

2.2 The reference line shall be maintained taut and free from sags at all times during spreading and initial compacting operations.

2.3 Except where the paver is matching a previously placed layer, a wire or cord reference line shall be installed on both sides of the paver for the initial bituminous course being laid. Thereafter only one reference line will normally be required, if the paver is equipped with adequate automatic superelevation control.

3. Spreading and Finishing

3.1 Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).

3.2 After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers. The mix may be spread and finished by approved hand methods only where the Engineer determines that machine methods are impracticable. Hand methods include heated hand tampers of at least 10 kg weight and approved type mechanical (vibratory) tampers.

3.3 The paver shall spread the bituminous mix without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

3.4 The paver shall be operated at a speed which gives the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mix to the paver. A uniform rate of placement shall be achieved without repeated intermittent operation of the paver.

3.5 The mix shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mix during daylight hours.

3.6 If during laying, the paver is repeatedly delayed because of lack of mix or if the paver stands at one location for an extended period, resulting in the (unrolled) mat under and adjacent to the rear of the spreader falling below the minimum temperature for breakdown rolling, the affected portion of mat shall be cut out and discarded and a transverse joint shall be constructed. Paving shall not recommence until the Engineer is satisfied that paving will proceed without interruptions.

3.7 Contact surfaces of curbing, gutters, manholes, and similar structures shall be painted with a thin, uniform coating of tack coat material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be 10 mm above the edge of such structure.

3.8 If during the paving operations, it is found that the spreading and finishing equipment in operation leaves in the pavement surface, tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by the scheduled operations, the use of the equipment shall be discontinued, until faults are corrected to the approval of the Engineer. If this is not possible, other satisfactory spreading and finishing equipment shall be provided by the Contractor.

3.9 Unless otherwise directed by the Engineer, where successive bituminous layers are to be placed, the surface of each existing layer shall be swept clean with a power broom, or by other approved means and a tack coat applied at the rate designated by the Engineer and in accordance with the relevant requirements of Section 4.02 - "Bituminous Prime and Tack Coats".

3.10 Transverse joints in succeeding layers shall be offset by at least 2 *m*. Longitudinal joints shall be offset at least 150 mm.

3.11 Bituminous mix shall be spread in one or more layers so that, after rolling, the nominal thickness of each layer of the compacted bituminous material does not exceed 2 to 3 times maximum size of aggregate. This maximum thickness may be increased slightly when such increase is more appropriate to total pavement thickness and provided the Engineer determines that such increased thickness will not be detrimental to the quality of the finished bituminous course, and the Contractor can show that the required density is attained throughout the layer thickness.

3.12 Transitions and structure approaches shall meet the design criteria for geometrics, the surface tolerance specifications, and shall not be visually discontinuous or abrupt in appearance.

3.13 Side roads, entrances and laybys shall be paved in accordance with the details shown on the Drawings.

4. Joints and Edges

4.1 All joints between old and new pavements or between successive days' work shall be such as to ensure thorough and continuous bond between the old and new material.

4.2 Before placing fresh mix against previously laid or against old pavement, the contact surface shall be cut back to a near vertical face, and shall be sprayed or painted with a thin uniform coat of tack coat material unless otherwise directed. Longitudinal joints shall be made by overlapping the paver screed on the previously laid material (cut back as necessary) and depositing a sufficient amount of fresh mix so that the joint formed will be smooth and tight.

4.3 The Contractor shall schedule paving operations so as to minimize the exposure of the leading lane of longitudinal joints prior to the completion and compaction of the joint. As a minimum, the leading lane shall not be laid in advance of the adjacent trailing lane by more than one half day of paving, and in no case shall the leading lane be more than 0.5 km ahead of the trailing lane without approval. In the event of failure to conform with these requirements, the Engineer may temporarily suspend paving on the leading lane.

4.4 Unsupported edges of bituminous layers shall be rolled immediately following the rolling of the longitudinal joint. The material along the unsupported edge may, if approved, be raised slightly by hand methods, to ensure that the full weight of the roller will bear fully on the edge material.

4.5 On completion, the longitudinal edges of bituminous pavement shall be true to the width and alignment as shown on the Drawings. The edges shall be cut back if necessary prior to rolling, additional mix placed manually in a longitudinal strip adjoining each pavement edge, and the edge rolled down to a neat 3:1 (H:V) slope or as shown on drawings.

4.6 Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged and string-lined to assure smoothness and true alignment. If the joint is formed with a bulkhead, such as a board, to provide a straight line and vertical face, it shall be checked with a straight edge before fresh material is placed against it to complete the joint. If a bulkhead is not used to form the joint and the roller is permitted to roll over the end of the new material, the line shall be located back of the rounded edge a sufficient distance to provide a true surface and cross-section. If the joint has been distorted by traffic or by other means, it shall be trimmed to line. In either case, the joint face shall be painted with a think coating of asphalt before the fresh material is placed against it.

5. Compaction

5.1 Rollers shall be operated by competent and experienced operators in accordance with the manufacturer's instructions, copies of which shall be submitted to the Engineer. Rollers shall be kept in operation continuously if necessary, so that all parts of the pavement receive substantially equal compaction at the time desired.

5.2 After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types, sizes and numbers of rollers. Rolling shall not be prolonged to the point where cracks appear or shoving or displacement occur.

5.3 All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatic-tired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at speeds slow enough to avoid displacement of the bituminous mix. The minimum numbers of rollers required is 3, of which one must be a pneumatic type. The Contractor shall select a suitable method and pattern of rolling that will achieve the required compaction, to the Engineers approval.

5.4 Prior to use on Site of pneumatic-tired rollers, the Contractor shall furnish, for reference and retention by the Engineer, manufacturers' charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor tire to be used. The Contractor shall ensure that tire pressures are maintained at all times in conformity with such charts or tabulations. The maximum allowable tolerances shall be plus or minus 35 kN/sq.m (5 psi).

5.5 Rollers should move at a slow but uniform speed, generally with the drive roll or wheels nearest the paver.

Recommended speeds are shown in Table 4.12 (kms/hr).

Table 4.12 Recommended Speeds of Rollers

	Breakdown	Intermediate	Finish
Steel Tired Static Weight Rollers	3	5	5
Pneumatic Tired Rollers	5	5	9
Vibratory Rollers	4.5	4.5	-

5.6 If vibratory rollers are used, when it is required to change direction the vibration should be turned off before the roller is stopped, and turned on after motion in the new direction begins.

5.7 Rolling shall begin as soon as the mixture will bear the roller weight without undue displacement. The minimum temperature of the mat at which rolling shall be allowed to start is 120°C.

5.8 Breakdown rolling shall consist of 3 complete coverages unless otherwise directed. Rolling shall be longitudinal, beginning at the low side of the spread of material and proceeding towards the high side, overlapping on successive trips by at least one half the width of the rear wheels. Alternate trips of the rollers shall be of slightly differing lengths.

5.9 The speed of the rollers, rolling pattern and, in the case of vibratory rollers, the frequency and amplitude of vibration, shall be approved by the Engineer. To prevent adhesion of the mix to the rollers, the wheels shall be kept properly and lightly moistened with water. An excessive use of water will not be permitted.

5.10 The rolling pattern, type and number of rollers shall be established by a site trial so as to achieve the required compaction. The approved rolling pattern shall be followed.

5.11 The initial or breakdown rolling shall be followed by intermediate rolling involving 3 coverages with pneumatic-tired rollers unless otherwise specified. Tire contact pressure shall be as approved.

5.12 Finishing rolling shall then be carried out by means of tandem power steel rollers unless otherwise designated. If, the specified density is not achieved, changes shall be made in size and number of rollers being used to ensure the compaction requirements are met.

5.13 The compacted density shall be equal to or greater than 97% and 98% for binder course and wearing course, respectively, of the average Marshall bulk specific gravity for each day's production unless otherwise directed by the Engineer, or allowed for in the Special Specification.

5.14 Any mix that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not conform in all other respects with the specified requirements shall be removed, replaced with suitable material and properly finished.

4.03.9 SAMPLING AND TESTING

1. Sampling and testing shall conform with the relevant requirements of Section 1.05 - "Control of Materials and Standards for Sampling and Testing", and Table 4.12.

Table 4.13: TEST FOR BITUMINOUS PAVEMENTS
Minimum Tests Required

Work item	(A) Tests at Source of material	Frequency for all tests mentioned under (A)	(B) Tests at road site	Frequency for all tests mentioned under (B)
4-1 Materials used in Aspalt mix (at batching plant)	1-Specific gravity and water absorption 2-Abrasion test 3-Chart content 4-Clay lumps and friable materials 5-Flaky and elongated particles 6-Soundness	-Test for each source -When materials quality changes -As requested		
4-2 Materials used in Asphalt mix (from hot bins)	1-Gradation 2-Specific gravity and water absorption 3-Plasticity index 4-Sand equivalent 5-Stripping with asphalt	-Test for each source -When materials quality changes -As requested		
4-3 Asphalt mix design each layer (At batching plant)	1-Complete mix design in accordance with American Asphalt institute (MS2) 2-Loss of stability	-For each project -When materials quality changes -When results are not consistent with the mix design results -As requested		

Table 4.13: (Continued)

Work item Frequency for tests mentioned under	(A) Tests at Source of material	Frequency for all tests mentioned under	(B) all site	Tests at road (A) (B)
4-4 Asphalt for each layer	At Batching plant 1-Stability 2-Flow 3-Extraction (binder content and gradation) 4-Air voids 5-Voids in mineral aggregates 6-Daily Marshall density	-Test each 3 working days -Test for each batching plant -As requested	Behind spreader 1-Stability 2-Flow 3-Extraction (binder content and gradation 4-Air voids 5-Voids in mineral aggregates 6-Daily Marshall density	-Test each working day -Test for each batch -As requested
	7-Loss of Stability	-Once a week -As requested	7-Hood density and thickness (after final compaction	-Test each 200 linm, per lane and for each layer -As requested
			8-Loss off stability	-Once a week -As requested

2. The Marshall bulk specific gravity shall be determined in accordance with AASHTO T 166 or AASHTO T 275. The Marshall specimens shall be prepared from the same material used in construction, taken from samples of fresh bituminous mix at the mixing plant or from trucks delivering mix to the Site. Oven heating for up to 30 minutes to maintain the heat of the sample is permissible.

3. The bulk specific gravity of the mix as placed and compacted in situ shall be determined from 100 mm nominal diameter core samples, or slab samples cut from each compacted layer on the road at locations designated by the Engineer who may require additional tests to determine limits of areas deficient in density, or for recheck.

4. Samples for in situ bulk specific gravity determinations shall be taken in sets of 2 from each pavement location. Minimum frequency of sampling for

each bituminous layer shall be one set/lane/500 m, with a minimum of one set per day of placing bituminous layers.

5. The Contractor shall cut the samples with an approved core drill in the presence of the Engineer. The equipment shall be capable of cutting the mixture without shattering the edges or otherwise disturbing the density of the specimen.

6. The Contractor shall, when necessary, furnish and apply cold water, ice, or other cooling substance to the surface of the pavement to prevent the sampling from shattering or disintegrating. The Contractor shall fill and compact all test holes at his own expense.

4.03.10 SURFACE TOLERANCES

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the Drawings.

2. The elevations of the finished course shall be checked by the Contractor in the presence of the Engineer at maximum intervals of 12.5m (half station) and at intermediate points as directed.

3. When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed the tolerances specified for each type of bituminous course laid.

4. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of bituminous course and reconstructing them or, if approved, by adding new material and recompacting and finishing to the specified standard or increasing the thickness of the succeeding course.

5. The tolerances specified for evenness of finished surfaces for all types of bituminous courses, shall not invalidate the tolerances specified for construction thickness and elevations of such courses.

4.03.11 DETERMINATION OF THICKNESS OF COURSES.

1. The Contractor shall compensate for minor deficiencies in the thickness of any bituminous course in the pavement structure by increasing the thickness of the subsequent bituminous course. After completion of the final (wearing) course any deficiencies in the thickness of any course which have not been compensated for by increasing the thickness of a subsequent course, will be considered deficiencies in the final (wearing) course.

2. Cylinder core samples shall be taken as specified for in situ bulk specified gravity core samples.

3. Thickness of bituminous courses shall be determined by average caliper measurement of cores, rounded upwards to the nearest mm.

4. Paved sections to be measured separately shall consist of each 300 lin.m section in each traffic lane. The last section in each traffic lane shall be 300 m plus the fractional part of 300 m remaining. Other areas such as intersections, entrances, crossovers, ramps, etc. shall be measured as one section and the thickness of each shall be determined separately. Small irregular unit areas may be included as part of another section.

5. One core shall be taken from each section by the Contractor at approved locations and in the presence of the Engineer. When the measurement of the core from any paved section is not deficient by more than 5 mm from the specified thickness, the core will be deemed to be of the specified thickness as shown on the Drawings.

6. When the measurement of the core from any paved section is deficient by more than 5 mm but not more than 20 mm, 2 additional cores spaced at not less than 100 m shall be taken and used together with the first core to determine the average thickness of such section.

7. When the measurement of the core from any paved section is less than the specified thickness by more than 20 mm, the average thickness of such section shall be determined by taking additional cores at not less than 5 m intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is taken which is not deficient by more than 20 mm. Exploratory cores for deficient thickness will not be used in average thickness determinations.

8. Any deficiencies in the total thickness of bituminous courses shall be subject to a proportional reduction in the area of final (wearing) course measured for payment. Alternatively, the Contractor shall construct all at his own expense, a wearing course overlay, if practicable in the judgement of the Engineer. Any such overlay shall be a minimum of 40 mm compacted thickness and to the specified standard of the course it is overlaying.

9. If the deficiency in total asphalt layers thickness is from 0 - 3mm, full payment will be made, on condition that deficiencies are not found in more than 10% of the total project. Deficiencies exceeding 3mm shall be left to the substantial handing-over procedure.

4.03.12 MEASUREMENT

1. Bituminous Courses shall be measured as prescribed in each of the respective Sections for each type of bituminous course constructed and accepted. Measurement shall not include the rolled down edge strips of bituminous courses placed outside the edge of paving as shown on the Drawings.

2. Bituminous Prime Coat and Bituminous Tack Coat shall be measured as prescribed in Section 4.02 - "Bituminous Prime and Tack Coats".

3. Bituminous overlays constructed by order of the Engineer to correct deficiencies in total thickness of bituminous courses or to compensate for major deficiencies in the thickness of any underlying bituminous course, shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

4. Establishment of the Job Mix Formula, surface preparation, construction of joints, hand painting of contact surfaces, remedial treatment of surface irregularities, cutting of cores and slabs for testing or measurement purposes, reinstatement of core and slab areas of pavement, rolled down longitudinal bituminous edge strips, additional thickness of bituminous course in excess of the specified thickness, and other ancillary items shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

SECTION 4.04 BITUMINOUS BASE COURSE

4.04.1 SCOPE

1. These Works shall consist of furnishing materials, mixing at a central mixing plant, and spreading and compacting bituminous base course on an approved sub-base course or subgrade, as and where shown on the Drawings.

4.04.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 4.01 - "Materials".

2. Unless otherwise shown on the Drawings, bitumen for base course construction shall be 60/70 penetration graded bitumen.

3. When an approved modifier (catalyst) is to be added and mixed with the bitumen, the bitumen used shall not be of lower penetration than 80/100 grade.

4.04.3 JOB MIX AND PROJECT MIX

1. The Job Mix Formula shall be established by the Contractor in accordance with the procedures and requirements of Section 4.03 - "Bituminous Courses".

2. The Job Mix for bituminous base course shall conform to the following composition limits as shown in Table 4.14. The particular job mix to be used in a project shall be given in the Special Specifications.

Table 4.14: JOB MIX REQUIREMENTS FOR BITUMINOUS BASE COURSE

Property	Heavy Traffic	Medium-Light Traffic
Marshall Stability at 60°C (Kg)	750	700
Flow (mm)	2 - 3.5	2 - 4
Voids in Mineral Aggregate (VMA)	12(min)	12(min)
Air Voids (%)	4 - 8	4 - 7
Filler Bit Ratio	1.2 - 1.5	1.0 - 1.4
Stiffness (Kg/mm)	300(min)	250(min)
*Loss of Stability (%)	25 (Max)	25 (Max)

* This test to be performed if directed by the Engineer or if required in the Special Specification. (this test is based upon AASHTO T165-86).

3. After the job mix formula has been established and approved, all mixes furnished shall conform to it within the stated tolerances.

4. The job Mix Formula shall be re-establish if the source of aggregate, filer or bitumen changes.

4.04.4 EQUIPMENT

1. Plant and equipment for mixing, hauling, placing and compacting bituminous base course material, shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.04.5 CONSTRUCTION OF TRIAL SECTIONS

1. Trial sections shall be constructed as and where directed and in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.04.6 MIXING PROCEDURES

1. Handling and mixing of bitumen (including modifier and antistripping agent, if any) and aggregates (including mineral filler if required) shall be in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.04.7 SURFACE PREPARATION

1. Preparation of the surface upon which the bituminous base course mix is to be laid, shall be appropriate to the type and condition of such surface and shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.04.8 DELIVERY, SPREADING AND FINISHING

1. General

1.1 The delivery, spreading and finishing of bituminous mix for base course shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the following particular requirements.

2. Rollers

2.1 Initial breakdown rolling shall be carried out by use of 2 dual-drum vibrating steel-wheeled vibrating rollers each of minimum weight 7,000 kg and with vibrating frequency of 2,000-3,000 cycles/min. These rollers shall be purpose made for compaction of hot bituminous courses.

2.2 Intermediate rolling shall be carried out by use of at least 2 self-propelled, tandem pneumatic smooth-tired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100 psi) and ballast - adjustable to ensure uniform wheel loadings.

2.3 Final rolling shall be carried out by use of 2, 2-axle tandem steel-tired rollers each of minimum weight 10,000 kg, capable of exerting contact pressures of up to 65 kg/cm (350 lb/in.).

2.4 The number of rollers used for any stage of rolling may be reduced by the Engineer to one, provided that the base course width being compacted is less than 5.5 m in width, and provided an equivalent standby roller is available on Site as replacement, in the event of breakdown of the operating roller.

3. **Standard of Compaction**

3.1 The compacted density of the bituminous base course shall be equal to or greater than 97% of the average Marshall bulk density for each day's production. The Special Specifications may require the degree of compaction of the bituminous base course to be expressed as a percentage of the maximum theoretical Specific Gravity of the mix.

4.04.9 SAMPLING AND TESTING

1. Sampling and testing shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12.

4.04.10 SURFACE TOLERANCES

1. Surface tolerances shall conform with the relevant requirements of Section 4.05 - "Bituminous Courses" and with the following particular requirements.

2. The tolerances on elevations of finished bituminous base course surface shall be not greater than plus 10 mm to minus 10 mm.

3. When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 8 mm.

4.04.11 DETERMINATION OF THICKNESS

1. Procedures for determining the average compacted thickness of bituminous base course shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the following particular requirements.

2. Cores for thickness measurements shall be used to determine if changes are necessary in the constructed thickness of succeeding bituminous layers to rectify any thickness deficiencies in the bituminous base course.

3. In any case where the bituminous base course will not be covered by superimposed binder or wearing courses, the base course shall be deemed to be the final (wearing) course for the purposes of determining the proportion of

wearing course area measured for payment or for the purposes of any overlay ordered to correct deficiencies.

4.04.12 MEASUREMENT

1. Bituminous Base Course shall be measured by sq.m of mix furnished, spread, compacted, completed and accepted. Measurements shall be of the areas and thickness as shown on the Drawings.

2. Where Bituminous Base Course is intended to serve as a wearing course, any deficiencies in thickness shall, unless an overlay is constructed at the Contractor's expense, result in a proportion only of the base course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions tabulated in Section 4.03 - "Bituminous Courses".

3. Bituminous prime coat shall be measured as prescribed in Section 4.02 - "Bituminous Prime and Tack Coats".

4. All other incidental items shall not be measured for direct payment, as prescribed in Section 4.03 - "Bituminous Courses".

SECTION 4.05: BITUMINOUS BINDER AND WEARING COURSES

4.05.1 SCOPE

1. These Works shall consist of furnishing materials, mixing at a central mixing plant, and spreading and compacting bituminous binder course and bituminous wearing course on an approved base course as and where shown on the Drawings.

4.05.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 4.01 - "Materials".

2. Unless otherwise shown on the Drawings, bitumen for binder and wearing courses construction shall be 60/70 penetration graded bitumen , and or any other suitable grade for the climatic condition of the project .

3. When an approved modifier (catalyst) is to be added and mixed with the bitumen, the bitumen used shall not be of lower penetration than 80/100 grade.

4.05.3 JOB MIX AND PROJECT MIX

1. The Job Mix Formula shall be established by the Contractor in accordance with the procedures and requirements of Section 4.03 - "Bituminous Courses".

2. The Job Mix for bituminous binder and wearing courses shall conform to the following composition limits, as shown in Table 4.15. The particular job mix to be used and shall be given in the Special Specification.

Table 4.15: JOB MIX REQUIREMENTS TO BITUMINOUS BINDER AND WEARING COURSES

Property	Heavy Traffic		Medium-Light Traffic	
	Binder	Wearing	Binder	Wearing
Marshall Stability at 60°C (kg)	900	1000	800	900
Flow (mms)	2 - 3.5	2 - 3.5	2 - 4	2 - 4
Voids in Mineral Aggregate (VMA)	13 (-1)	14 (-1)	13 (-1)	14 (-1)
Air Voids (%)	4 - 7	4 - 6	3 - 5	3 - 5
Stiffness (Kg/mm)	500 (Min)	500 (Min)	400 (Min)	400 (Min)
* Loss of stability (%)	25 (max)	25 (max)	25 (max)	25 (max)

* This test to be carried out in accordance with AASHTO T165-82.

3. After the Job Mix Formula has been established and approved, all subsequent mixes shall conform to it within the allowable tolerances.

4. The Job Mix Formula shall be re-established if the source of aggregate, filler or bitumen is changed.

4.05.4 EQUIPMENT

1. Plant and equipment for mixing, hauling, placing and compacting bituminous binder course and wearing course materials, shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.05.5 CONSTRUCTION OF TRIAL SECTIONS

1. Trial sections shall be constructed as and where directed and in accordance with the relevant requirements of Section 4.05 - "Bituminous Courses".

4.05.6 MIXING PROCEDURES

1. Handling and mixing of bitumen (including modifier and antistripping agent, if any) and aggregates (including mineral filler if required) shall be in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.05.7 SURFACE PREPARATION

1. Preparation of the surface upon which the bituminous binder course and the bituminous wearing course mixes are to be laid, and the use of prime and tack coats, shall be appropriate to the type and condition of such surfaces and shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.05.8 DELIVERY, SPREADING AND FINISHING

1. General

1.1 The delivery, spreading and finishing of bituminous mixes for binder and wearing courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the following particular requirements.

2. Rollers

2.1 Initial breakdown rolling shall be carried out by use of 2 dual-drum vibrating steel-wheeled vibrating rollers each of minimum weight 7,000 kg and with vibrating frequency of 2,000-3,000 cycles/min. These rollers shall be purpose made for compaction of hot bituminous courses.

2.2 Intermediate rolling shall be carried out by use of at least 2 self-propelled, tandem pneumatic smooth-tired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100 psi) and ballast - adjustable to ensure uniform wheel loadings.

2.3 Final rolling shall be carried out by use of 2, 2-axle tandem steel-tired rollers each of minimum weight 10,000 kg, capable of exerting contact pressures of up to 65 kg/cm (350 lb/in.).

2.4 The number of rollers used for any stage of rolling may be reduced by the Engineer to one, provided that the course being compacted is less than 5.5m in width, and provided an equivalent standby roller is available on Site as replacement, in the event of breakdown of the operating roller.

3. **Standard of Compaction**

3.1 The compacted density of the bituminous wearing course shall be not less than 98% of the average Marshall bulk density for each day's production.

3.1 The Special Specification may require the degree of compaction to be expressed as a percentage of the maximum theoretical specific gravity of the mix.

4.05.9 SAMPLING AND TESTING

1. Sampling and testing shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12.

4.05.10 SURFACE TOLERANCES

1. Surface tolerances shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the following particular requirements.

2. The tolerances on elevations of the final bituminous wearing course surface shall not be greater than 10mms.

3. When the finished wearing course surface is tested with a 3m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 5.0 mm.

4. The combination of the permitted tolerances in the levels of the different pavement layers, excluding aggregate base and sub-base courses, shall not result in a reduction of thickness by more than 10mms from the specified thickness, as shown on the drawings, nor a reduction in the final wearing course thickness by more than 5mm from that specified or shown on the drawings.

4.05.11 DETERMINATION OF THICKNESS

1. Procedures for determining the average compacted thickness of bituminous binder and wearing courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses" and with the following particular requirements.

2. Cores for thickness measurements of the binder course shall be used to determine if changes are necessary in the constructed thickness of the wearing course to rectify any thickness deficiencies in the binder course.

4.05.12 MEASUREMENT

1. Bituminous Binder Course and Bituminous Wearing Course shall be measured by sq.m of mix furnished, spread, compacted, completed and accepted. Measurements shall be of the areas and thickness as shown on the Drawings.

2. Deficiencies in thickness of the wearing course shall, unless an overlay is constructed at the Contractor's expense, result in a proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions tabulated in Section 4.03 - "Bituminous Courses".

3. Bituminous Prime Coat and Bituminous Tack Coat shall be measured as prescribed in Section 4.02 - "Bituminous Prime and Tack Coats".

4. All other incidental items shall not be measured for direct payment, as prescribed in Section 4.03 - "Bituminous Courses".

SECTION 4.06: BITUMINOUS SEAL COATS

4.06.1 SCOPE

1. These Works shall consist of the furnishing of materials and one or more applications of cutback bitumen and cover material, or a single application of emulsified bitumen, or spreading emulsified bitumen slurry, to previously prepared base course or wearing course surfaces, as and where shown on the Drawings.

2. Bituminous Slurry Seal Coat (BSSC) shall consist of spreading and screeding a mixture of emulsified bitumen, sand aggregate and water.

3. Single Bituminous Seal Coat (SBSC) shall consist of a single application of cutback or straight run bitumen, and sand aggregate or as specified.

4. Double Bituminous Seal Coat (DBSC) shall consist of an application of cutback or straight run bitumen and (coarse graded) cover aggregate followed not less than 5 days later by a second application of cutback or straight run bitumen and (medium graded) aggregate, or as specified.

4.06.2 MATERIALS

1. Bitumen

1.1 Bitumen for SBSC and DBSC (seal coat) applications shall be Rapid-Curing RC-800 Grade and or any suitable grade conforming with the relevant requirements of Section 4.01 - "Materials", and AASHTO M-81.

1.3 Bitumen for BSSC (slurry) applications shall be a cationic, slow setting emulsified bitumen Grade CSS-1 or CSS-1h, conforming with the relevant requirements of Section 4.01 - "Materials", unless otherwise specified in the Special Specification.

2. Aggregates

2.1 Cover aggregates shall consist of screenings of crushed stone or crushed gravel. Aggregate for slurry seals shall consist of crushed stone or gravel fines or natural sand blended with not less than 50% crushed fines. For heavy duty applications slurry aggregate shall consist of 100% crushed fines.

2.2 The properties of cover and slurry seal aggregates and their gradations shall be in accordance with the relevant requirements of Section 4.01 - "Materials".

4.06.3 EQUIPMENT

1. All plant and equipment used for pugmill mixing of slurry mixes, heating and spraying of cutback and emulsified bitumen, spreading, rolling and brooming of cover aggregate, and applying and spreading slurry seals, shall conform with the requirements of Section 1.14 - "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

4.06.4 CONSTRUCTION OF TRIAL SECTIONS

1. Before commencement of Site seal coat applications, the Contractor shall construct trial sections using varying application rates for bitumen and for aggregates, as selected by the Engineer. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site.

2. Each trial section shall be constructed using the same materials, mixing, spraying, spreading, rolling and brooming equipment, and construction procedures, proposed for use in the Works. Trial sections for slurry seals shall be along existing bituminous pavements in the vicinity of the Site.

3. The objectives of these trials shall be to determine the adequacy of the Contractor's equipment, the most suitable application rates for cutback bitumen, emulsified bitumen and the various gradations of aggregate, and the most suitable consistency of slurry seal to fill cracks and leave a residual coating of 3 mm over the entire bituminous wearing surface.

4. The Contractor shall not proceed with any seal coat applications until the methods and procedures established in the trials have been approved.

4.06.5 RATES OF APPLICATION

1. Application rates for cutback and emulsified bitumen and for the various cover aggregate gradations, will be determined by the Engineer from the trial sections and shall be generally within the ranges given in Table 4.16.

Table 4.16: APPLICATION RATES

Types of seal coat	Approx. rate of application	
	Aggregate (Kg/sq.m)	Binder (Kg/sq.m)
Coarse agg. seal coat	12.5- 20.0	1.00-1.80
Medium agg. seal coat	10.0-15.0	0.90-1.80
Slurry seal	Generally 5-6 Kg/m^2 for the mix	

2. The Engineer may order additional trial sections and alter the previously established rates of application during progress of the Works.

4.06.6 CONSTRUCTION

1. General

1.1 Applications of bitumen and aggregate and subsequent rolling shall be completed between sunrise and sunset and under favourable weather conditions as determined by the Engineer. The atmospheric temperature shall be above 15 degrees C and the weather shall not be foggy, rainy, dusty or unduly windy.

1.2 Generally, where the seal coat is to carry traffic prior to final sweeping, speed signs shall be erected to control the speed of traffic. Provision for traffic control shall be in accordance with the relevant requirements of Section 8.10 - "Maintenance of Traffic and Detours".

1.3 When bituminous coatings are applied to sections of highway which are to be promptly opened to traffic, and the ambient temperature is contributing to slow curing and excessive pickup, the Contractor shall suspend operations until the Engineer approves continuation of sealing Works.

1.4 The surface to be treated shall be dry or slightly damp and the moisture content of aggregates at the time of application to the coated surface shall not exceed 3% by weight.

1.5 Unless otherwise directed, the minimum time interval between successive seal coats, in DBSC and TBSC applications, shall be 5 days.

2. Surface Preparation

2.1 Granular surfaces shall be primed in accordance with the requirements of Section 4.02 - "Bituminous Prime and Tack Coats" prior to construction of the surface treatment. If there are delays in scheduling the seal coating, which results in deterioration of the surface, the Engineer may order appropriate repairs or corrective treatment prior to seal coating.

2.2 When coatings are applied to existing pavement surfaces, all pavement repairs shown on the Drawings shall first be completed. Where applicable, the positions of traffic markings shall be surveyed and recorded to enable their accurate replacement after the seal coatings have been applied.

2.3 Immediately before applying any bituminous material, all dirt, dust and other objectionable material shall be removed from the surface and cracks shall be repaired or sealed as directed. If required, the surface shall be slightly dampened with a light application of water immediately prior to application of bitumen.

2.4 Surfaces to be slurry sealed shall be lightly sprayed, immediately prior to spreading the slurry, with a slow-curing 3:1 water:emulsion mixture applied at the rate of 0.4-0.8 ltr/sq.m.

3. Heating of Bitumen

3.1 The temperature of cutback bitumen and of emulsified bitumen at the time of application shall be as specified in Section 4.01 - "Materials".

4. Spreading Slurry Seal

4.1 Spreading of slurry seal shall be by means of an approved type spreader box which shall be capable of spreading at least one traffic lane width. It shall have flexible rubber or similar strips fastened on each side to prevent loss of slurry and shall have baffles incorporated in the box to ensure uniform application. A rear, flexible strike-off blade of adjustable type shall also be provided.

4.2 Areas inaccessible to the slurry spreader box shall be slurry sealed using hand or other approved methods.

4.3 The slurry seal coat shall be uniform and homogeneous after spreading and shall not show signs of separation of the emulsion and aggregate after setting.

5. Spraying of Bitumen

5.1 The bitumen cutback or emulsified bitumen for fog and seal coats shall be applied by means of a pressure distributor uniformly and continuously over the section to be treated. The rate of application shall be as designated by the Engineer.

5.2 A strip of building paper or heavy polyethylene sheeting, at least one m in width, and with a length equal to that of the spray bar of the distributor plus 300 mm shall be used at the beginning of each application. If the cut-off is not positive, the paper shall be used at the end of each spread. The paper shall be removed and disposed of, after use. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected immediately as directed.

5.3 The length of spray run shall not exceed that which can be covered by the aggregate spreading equipment.

5.4 The application width of bitumen shall be not more than 150 mm wider than the width covered by the aggregate spreader. Under no circumstances shall operations proceed in such a manner that the bitumen will be allowed to chill, set up, dry, or otherwise impair retention of the cover aggregate.

5.5 The Contractor shall keep a complete record of bitumen used, based on distributor tank measurements and on areas to which the bitumen has been applied. These records shall be submitted to the Engineer as verification of the accuracy of the tachometer as well as verification of application rates designated by the Engineer.

5.6 Distribution of bitumen shall be so regulated and sufficient material left in the distributor at the end of each application, that there will be a uniform distribution across the spray bar. In no case shall be distributor be allowed to expel air with the bitumen, thereby causing uneven coverage.

5.7 The angle of the spray nozzles and the height of the spray bar shall be adjusted and regularly checked to ensure uniform distribution. The height of the spray bar above the pavement surface should remain constant throughout the spraying process. Distribution shall cease immediately upon any clogging or

partial blocking of any nozzle and corrective measures shall be taken before application is resumed.

6. Application of Aggregate

6.1 If directed, aggregates shall be washed prior to use in order to eliminate or reduce any dust coating or salts before delivery to the spreader.

6.2 Operation of the aggregate spreader at speeds which cause the particles to roll over after striking the bitumen covered surface will not be permitted.

6.3 Immediately upon application of bitumen, aggregate of the required gradation shall be spread at the rate designated by the Engineer. Spreading shall be accomplished in such a manner that the tires of the hauling units or aggregate spreader do not come in contact with the uncovered bitumen surface.

6.4 Where adjacent spreads are to be made, the first aggregate spread shall not extend closer than 150 mm to the edge of bitumen application. The adjacent spread of bitumen shall overlap this 150 mm and complete aggregate coverage shall be achieved on the second spread promptly upon completion of the first spread to ensure a smooth riding surface.

6.5 Immediately after aggregate has been spread, deficient areas shall be covered by additional aggregate. Piles, ridges or uneven distributions of aggregate shall be removed and corrected to insure against permanent ridges, bumps, or depressions in the completed surface. Additional aggregate shall be spread in whatever quantities necessary to prevent pick-up by rollers or traffic, after which the surface shall be rolled as directed.

6.6 Care shall be taken to prevent aggregate from entering ditches or inlets of any type. The Contractor shall be responsible for removal of any such aggregate materials or other accumulated debris arising out of his operations.

7. Rolling and Brooming

7.1 Aggregate shall not be spread more than 150 m ahead of initial rolling operations.

7.2 Rollers shall not stop, start or turn on the surface being rolled. Any damage to the surface arising out of non-compliance with these requirements shall be made good as directed, at the Contractor's expense.

7.3 Initial "breakdown" rolling shall proceed behind the spreader (after any adjustments by hand methods to correct for uneven distribution, etc). One complete coverage shall be achieved using 2-axle self-propelled steel-wheeled

rollers of 6-8 tons weight and operating at a maximum speed of 5 km/h. Initial rolling shall be completed within 30 minutes of spreading aggregate.

7.4 The Engineer may order the alternative use of pneumatic-tired rollers for initial rolling if the achievement of adequate embedment of the aggregate is liable to result in excessive crushing when steel-wheeled rollers are used.

7.5 Immediately following completion of the initial rolling, the surface shall be rolled using self-propelled pneumatic-tired rollers operated at a maximum speed of 8 km/h, until at least 3 complete coverages have been achieved.

7.6 If necessary during rolling operations, additional screenings shall be lightly spread by hand methods and re-rolled, to make good any small areas visibly deficient in cover material.

7.7 Light drag brooming of the surface shall be carried out 24 hours after completion of rolling and in such a manner that embedded aggregate particles will not be dislodged. This brooming shall result in uniform distribution of loose screenings over the surface which shall then be re-rolled using pneumatic-tired rollers until at least 2 complete coverages have been achieved.

7.8 Light drag brooming and re-rolling shall be repeated 24 hours after the initial brooming, if so directed.

7.9 Excess (surplus) screenings shall be salvaged and stockpiled or disposed of as directed.

8. Maintenance and Protection of Sealed Surfaces

8.1 BFSC and BSSC shall be protected from traffic until such time as the coatings have cured sufficiently and will not be damaged by, adhere to or be picked up by, the tires of vehicles.

8.2 Each coat of SBSC and DBSC shall be maintained and protected from traffic for at least 3 days after completion of rolling.

8.3 At the end of the 3-day maintenance period for each seal coat, or earlier if directed, the surface shall be finally swept, using a rotary broom, to remove loose screenings. Surplus screenings shall be stockpiled or disposed of as directed.

8.4 Adequate traffic control (including speed control measures) shall be taken during the maintenance periods, in accordance with the relevant requirements of Section 8.10 - "Maintenance of Traffic and Detours".

4.06.7 TOLERANCES AND RECORDS

1. The Contractor shall be responsible for ensuring the accurate calibration of pressure distributors and for the correct rates of application of bitumen as designated by the Engineer.

2. Readings shall be taken of bitumen tanker contents and temperature immediately prior to, and immediately upon completion of each spraying run and the actual application rate in kg/m^2 shall be calculated. Complete records shall be maintained of all such measurements and the specific locations, width and lengths of the respective runs.

3. The tolerances on temperature adjusted application rates of cutback bitumen shall be plus or minus 5% of the designated rate.

4. Applications of cutback bitumen varying by more than 5% but less than 10%, after temperature adjustment, below the specified rate of application shall, if accepted, be subject to a 10% reduction in quantity or area measurements as appropriate.

5. Applications of cutback bitumen varying by more than 5% but less than 10%, after temperature adjustment, above the specified rate of application shall, if accepted, be measured on the basis of the designated application rate.

6. Applications of cutback bitumen varying by more than 10%, after temperature adjustment, above or below the specified rate of application shall be rejected and the unsatisfactory material replaced or made good as directed, at the Contractor's expense.

7. The Contractor shall maintain, on a daily basis, complete records of the volumes and tonnage of each type of aggregate delivered to the Site and used in each section of the Works for seal coat applications.

8. All records and calculations of bitumen applications, and aggregate delivery and use, shall be submitted to the Engineer at the end of each day when seal coat applications have been carried out. No measurements will be made of bitumen applications which are not supported by adequate, verifiable records.

4.06.8 MEASUREMENT

1. The quantity of seal coat to be paid for shall be the number of square meters for each application as entered in the Bill of Quantities. No separate payment shall be made for bituminous material, or cover aggregates.

SECTION 4.07: BITUMINOUS LEVELING COURSE

4.07.1 SCOPE

1. These Works shall consist of furnishing materials, mixing at a central mixing plant, and spreading and compacting bituminous wearing course on an existing pavement surface, as and where shown on the Drawings or directed.

4.07.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 4.01 - "Materials".

2. Unless otherwise shown on the drawings materials shall conform with the requirements of Section 4.05 - "Bituminous Binder and Wearing Courses".

4.07.3 JOB MIX AND PROJECT MIX

1. The Job Mix Formula shall be established by the Contractor in accordance with the procedures and requirements of Section 4.03 - "Bituminous Courses".

2. The Job Mix for bituminous leveling shall conform with the requirements of Section 4.05 - "Bituminous Binder and Wearing Courses".

4.07.4 EQUIPMENT

1. Plant and equipment for mixing, hauling, placing and compacting bituminous leveling course materials shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.07.5 CONSTRUCTION OF TRIAL SECTIONS

1. Trial Sections shall be constructed as and where directed and in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.07.6 SURFACE PREPARATION

1. Damaged pavement surfaces shall, where directed, be repaired by patching prior to receiving the bituminous levelling course. The extent of patching shall be as shown on the Drawings or as directed.

2. Areas of existing pavement to be patched shall be cut out to neat lines to a depth ordered by the Engineer, thoroughly cleaned, and the exposed edges of pavement painted or sprayed with a thin coat of rapid curing cutback bitumen Grade RC-70 or RC-250 in accordance with the relevant requirements of Section 4.02 - "Bituminous Prime and Tack Coats". The cut out pavement shall be patched with bituminous material as shown on the Drawings or as directed and conforming with the relevant requirements of Section 4.01 - "Materials".

3. Patching shall be carried out in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4. Patching shall be carried out in layers not exceeding 80 mm in thickness. Each layer shall be thoroughly compacted by means of approved pneumatic tampers prior to placing the succeeding layer. Each layer shall be protected from damage and all dirt or foreign material shall be removed before placing subsequent layers. The final layer shall be rolled with a heavy roller. Each layer shall be approved prior to placement of subsequent layers.

5. All cut-out pavement material and surplus patching material shall be removed from the site and disposed of by the Contractor prior to placing the levelling courses.

6. In areas where leveling courses are required, as shown on the Drawings or directed, the Contractor shall take cross sections of the existing pavement after completing any patching. The cross sections will be taken at intervals of 12.5 meters or as directed. When the survey is approved, the Engineer will determine and inform the Contractor of the locations, grades and thicknesses of leveling courses to obtain the desired surface.

7. Prior to placing the leveling courses the existing pavement surface shall be prepared in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses", including the use of prime and tack coats as appropriate.

4.07.7 DELIVERY, SPREADING AND FINISHING

1. The delivery, spreading and finishing of leveling courses, including compaction, shall conform with the relevant requirements of Section 4.05 - "Bituminous Binder and Wearing Courses".

2. In areas where a specific grade and superelevation are to be achieved by the leveling courses, setting out and level control shall be based on a reference line installed in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses". In areas of minor leveling such as filling of pits or small isolated areas, a mobile reference line or alternative control system may be approved.

4.07.8 SAMPLING AND TESTING

1. Sampling and testing of levelling courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12..

2. Where sampling and testing are not feasible due to thickness or other constraints, the Engineer will determine specification compliance based on an approved rolling pattern or other basis.

4.07.9 SURFACE TOLERANCES

1. Surface Tolerances for levelling courses shall conform with the relevant requirements for Binder Courses in Section 4.04 - "Bituminous Base Course".

4.07.10 DETERMINATION OF THICKNESS

1. The Engineer may use thickness measurements, spread rates, cross section or other methods to verify quantities placed. Thickness measurements shall be in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.07.11 MEASUREMENT

1. Bituminous levelling courses shall be measured by the cu.m of mix furnished, spread, compacted, completed and accepted. Measurements shall be based on the areas and thicknesses shown on the Drawings or as directed.

2. Patching shall be measured by the cu.m of mix furnished, spread, compacted, completed and accepted. Measurements shall be based on the areas and thicknesses shown on the Drawings as directed.

3. Bituminous Tack Coat shall be measured as prescribed in Section 4.02 - "Bituminous Prime and Tack Coats".

4. All other incidental items shall not be measured for direct payment, as prescribed in Section 4.03 - "Bituminous Courses".

SECTION 4.08: BITUMINOUS COLD MIX COURSES

4.08.1 SCOPE

1. These Works shall consist of furnishing materials, mixing manually or at a central mixing plant, or in a travel-mix plant and spreading and compacting bituminous cold mix courses comprising unheated mineral aggregate or cut-back asphalt on a prepared surface, as and where shown on the Drawings or directed.

4.08.2 MATERIALS

1. All materials shall conform with the relevant requirements of Section 4.01 - "Materials".

2. The type and grade of bitumen for the paving mixture shall be as shown on the Drawings or as directed. The bitumen shall conform with the relevant requirements of AASHTO M81,M82, M140 or M208.

4.08.3 JOB MIX AND PROJECT MIX

1. The Job Mix Formula shall be established by the Contractor in accordance with the procedures and requirements of Section 4.03 "Bituminous Courses".

2. The Job Mix shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course" or Section 4.05 - "Bituminous Binder and Wearing Courses".

4.08.4 EQUIPMENT

1. Plant and equipment for mixing, hauling, placing and compacting bituminous cold mix courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses". In the continuous mixing plant, the devices feeding asphalt, aggregate and water shall be interlocked to maintain automatically the correct proportions. In a travel mix plant, the equipment used may be either a hopper type, or a rotary type mixer. Both types of equipment should be capable of thoroughly mixing the asphalt and aggregate, uniformly dispersing the asphalt, and adequately coating the aggregate particles producing a uniform mix.

4.08.5 CONSTRUCTION OF TRIAL SECTIONS

1. Trial Sections shall be constructed as and where directed and in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.08.6 MIXING PROCEDURES

1. Handling and mixing of bitumen and aggregate shall be in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses" with the following exceptions:

1.1 Aggregates shall not be heated but shall be fed cold to the plant. The temperature of the bitumen upon entering the pugmill shall be adequate to ensure uniform application to the cold aggregate. The bitumen temperature shall be designated by the Engineer and shall be in general accordance with the relevant requirements of Section 4.01 - "Materials".

1.2 Mixing time shall be the shortest time necessary to remove excess volatiles or water and to produce a satisfactory mixture.

4.08.7 SURFACE PREPARATION

1. Preparation of the surface upon which bituminous cold mix courses are to be laid, and the use of prime and tack coats, shall be appropriate to the type and condition of such surfaces and shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.08.8 DELIVERY, SPREADING AND FINISHING

1. The delivery, spreading and finishing of bituminous cold mix courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

2. Requirements for rolling and compaction shall comply with the relevant requirements of Section 4.06 - "Bituminous Base Courses" or Section 4.05 - "Bituminous Binder and Wearing Courses".

4.08.9 SAMPLING AND TESTING

1. Sampling and testing shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12.

4.08.10 SURFACE TOLERANCES

1. Surface tolerances shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Courses".

2. Finished elevations and straight edge tolerances shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Courses" or Section 4.05 - "Bituminous Binder and Wearing Courses".

4.08.11 DETERMINATION OF THICKNESS

Procedures for determining the average compacted thickness of bituminous cold mix courses shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

Cores for thickness measurements of bituminous cold mix courses shall be used to determine if changes are necessary in the thickness of succeeding layers in accordance with the relevant requirements of Section 4.04 - "Bituminous Base Course" or Section 4.05 - "Bituminous Binder and Wearing Courses".

4.08.12 MEASUREMENT

1. Bituminous cold mix courses shall be measured by the sq.m. of mix furnished, spread, compacted, completed and accepted. Measurements shall be of the areas and thicknesses as shown on the Drawings.

2. Deficiencies in thickness of bituminous cold mix wearing course shall, unless an overlay is constructed at the Contractor's expense, result in a proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions tabulated in Section 4.03 - "Bituminous Courses".

3. Bituminous prime coat and bituminous tack coat shall be measured as prescribed in Section 4.02 - "Bituminous Prime and Tack Coats".

4. All other incidental items shall not be measured for direct payment, as prescribed in Section 4.03 - "Bituminous Courses".

SECTION 4.09: RECYCLED BITUMINOUS BASE COURSE

4.09.1 SCOPE

1. These Works shall consist of removal, crushing and stockpiling existing bituminous pavement, mixing with new aggregate, bitumen (and, if specified, an approved modifying agent) at a central , in place (hot) mixing plant, and spreading and compacting recycled bituminous base course on a prepared surface, as and where shown on the Drawings or directed.

4.09.2 MATERIALS

1. Recycled material shall consist of existing bituminous pavement, processed such that 100% will pass the 37.5 mm (1.5 in) sieve.

2. If the Engineer determines that recycled bituminous material is causing degradation of the aggregate, he shall revise the job-mix as required.

3. New materials shall conform with the relevant requirements of Section 4.01 - "Materials".

4. Unless shown otherwise on the Drawings, bitumen for recycled bituminous base course shall be Graded to suit the project climatic condition and type of work , if not specified grade 60-70 penetration conforming with the requirements of AASHTO M20 shall be used or as shown on the drawing .

5. Modifying agent used to soften the old bitumen shall in accordance with the design and approved by the Engineer.

6. Existing pavement shall be removed in such a manner as to prevent unnecessary intermixing with the underlying base, sub-base or subgrade material.

7. The stockpile height shall not be greater than 3 meters. Construction equipment will not be permitted on the stockpiles.

4.09.3 JOB MIX AND PROJECT MIX

1. The Job Mix Formula shall be established by the Contractor in accordance with the procedures and requirements of Section 4.03 - "Bituminous Courses".

2. The properties of the new modified mix shall meet all the requirment as specified .

4.09.4 EQUIPMENT

1. The Job Mix for recycled bituminous base course shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course", subject to any modifications by the Engineer.

2. Plant and equipment for milling mixing, hauling, placing and compacting recycled bituminous base course materials shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses". Mixers shall have a filter unit to stop pollution of the environment.

4.09.5 CONSTRUCTION OF TRIAL SECTIONS

1. Trial Sections shall be constructed as and where directed and in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.09.6 MIXING PROCEDURES

1. Handling and mixing of bitumen (including modifier and anti-stripping agent, if any) and aggregate (including recycled material, new aggregate and mineral filler if required) shall be in accordance with the relevant requirements of Section 4.03 - "Bituminous Courses".

2. Crushing of existing pavement materials for recycling may be accomplished by portable or stationary crushers or may be the direct result of the pavement removal method such as cold milling.

3. Crushed pavement materal shall be separated into a minimum of two sizes prior to heating and mixing. The fine size shall have a minimum of 80% passing the 4.75mm (No.4) seive. The coarse size shall have a minimum of 60% retained on the 4.75mm (No.4) seive.

4. Heated and dried new aggregate shall be combined in the appropriate proportions and gradations with the recycled bituminous material and mixed at such temperature and for such time necessary to achieve a thorough coating of the new aggregate. New bitumen and/or modifier shall then be incorporated into the mixture and mixed to produce a homogenous mixture with satisfactory coating of all aggregate.

5. If both bitumen and modifier are used they shall be introduced into the mixing area through separate metering devices.

6. Preheating of the crushed recycled bituminous material immediately before introduction to the mixer may be permitted subject to the approval of

the Engineer. Preheating methods shall not result in loss of bitumen from the recycled material.

4.09.7 SURFACE PREPARATION

1. Preparation of the surface upon which the recycled bituminous base course is to be laid shall be appropriate to the type and condition of such surface and shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses".

4.09.8 DELIVERY, SPREADING AND FINISHING

1. The delivery, spreading and finishing of recycled bituminous base course shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course".

4.09.9 SAMPLING AND TESTING

1. Sampling and testing of recycled bituminous base course shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12.

4.09.10 SURFACE TOLERANCES

1. Surface tolerances shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course".

4.09.11 DETERMINATION OF THICKNESS

1. Procedures for determining the average compacted thickness of recycled bituminous base course shall be in accordance with the requirements of Section 4.04 - "Bituminous Base Course".

4.09.12 MEASUREMENT

1. Recycled bituminous base course shall be measured by the sq.m of mix furnished, spread, compacted, completed and accepted. Measurement shall be of the areas shown on the Drawings.

2. Removal and crushing of existing pavement materials for incorporation in recycled bituminous base course shall not be measured for direct payment.

3. Bituminous prime coat shall be measured as prescribed in Section 4.02 "Bituminous Prime and Tack Coats".

All other incidental items shall not be measured for direct payment, as escribed in Section 4.03 - "Bituminous Courses".

SECTION 4.10: PAVEMENT REPAIRS AND TRENCH REINSTATEMENT WORKS

4.10.1 SCOPE

1. These Works shall consist of removing defective bituminous pavement, preparing surfaces to receive repairs, furnishing materials, placing and finishing new pavement, as and where shown on the Drawings or directed.

4.10.2 MATERIALS

1. All pavement materials shall conform with the relevant requirements of Section 4.01 - "Materials" and Section 3.01 - "Materials".

2. Subgrade materials shall conform with the relevant requirements of Section 2.07 - "Subgrade Construction and Topping".

4.10.3 EQUIPMENT

All plant and equipment shall conform with the relevant requirements of Section 1.12 - "Contractors Plant and Equipment".

4.10.4 PREPARATION OF PAVEMENT

1. Cracks in bituminous pavement which, in the opinion of the Engineer, do not require reconstruction shall be prepared by wire brushing and blowing out with compressed air.

2. Defective bituminous pavement which, in the opinion of the Engineer, requires reconstruction shall be cut back to good material using pneumatic cutting tools. The cut edges shall be square or rectangular and in line with the direction of traffic. The depth of cut shall be determined by the Engineer and may include asphaltic layers, base and sub-base layers and subgrade layers (in the case of failed pavement, excavation shall include a minimum of 300 mm of subgrade material). All excavated materials shall be removed and disposed of off-site. When the bottom of the excavation consists of earth or granular material it shall be thoroughly compacted using mechanical compactors to the satisfaction of the Engineer. Excavated bituminous surfaces shall be thoroughly cleaned and wire brushed prior to receiving repair materials.

3. Utility trench reinstatements in bituminous pavement shall be prepared in the same way as defective bituminous pavement. Excavation shall include a minimum of 300 mm of subgrade material.

4.10.5 PLACING AND FINISHING REPAIR MATERIALS

1. Cracks of 3 mm width or wider shall be filled with clean, coarse sand then saturated with 1:1 diluted emulsified bitumen , or as directed . Cracks of less than 3 mm shall be filled with emulsified bitumen , or as directed. Cracks shall be filled to the road surface. Any excess bitumen shall be removed with a squeegee and the bitumen surface shall be sprinkled liberally with coarse sand.

2. Excavations below subgrade level shall be filled to a level specified by the Engineer with subgrade material in layers not exceeding 150 mm and compacted using mechanical compactors to conform with the requirements of Section 2.07 - "Subgrade Construction and Topping" and to the satisfaction of the Engineer.

3. Sub-base and/or base course, if required, shall be placed in layers not exceeding 150 mm and compacted using mechanical compactors. They shall conform with the relevant requirements of Section 3.02 - "Granular Sub-Base Courses" or Section 3.03 - "Aggregate Base Courses" and shall be to the grading shown on the Drawings or specified by the Engineer.

4. Prior to receiving bituminous material the excavations shall be thoroughly cleaned. Subgrade, sub-base or base course material shall be primed with a light coating of MC cutback bitumen and existing bituminous surfaces shall be lightly painted with emulsified bitumen, all in accordance with the requirements of Section 4.02, "Bituminous Prime and Tack Coats".

5. The excavation shall be filled with bituminous pavement materials placed in layers not exceeding 70 mm and compacted using vibratory compactors. Unless ordered to the contrary by the Engineer, the top layer shall be compacted by steel wheeled roller, first compacting the 150 mm strips adjacent to the traffic edges, then rolling in the direction of traffic. Bituminous materials shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course" and Section 4.05 - "Bituminous Binder and Wearing Courses" and shall be to the gradings shown on the Drawings or specified by the Engineer.

6. New utility trenches shall be backfilled to the details shown on the Drawings, or ordered, including any surrounds, haunching or protective materials. Construction of subgrade and pavement shall be as for pavement repairs.

7. No excavated areas shall remain open overnight.

4.10.6 SAMPLING AND TESTING

1. Testing of repair materials shall conform with the relevant requirements of Section 4.03 - "Bituminous Courses", and Table 4.12. Sampling shall be as ordered by the Engineer.

4.10.7 SURFACE TOLERANCES

1. Levels shall be checked by straight edge in relation to the adjacent existing pavement.

2. Surface tolerances for bituminous layers shall conform with the relevant requirements of Section 4.04 - "Bituminous Base Course" and Section 4.05 - "Bituminous Binder and Wearing Courses".

3. Any deficiency in the wearing course surface will be corrected by cutting out and replacing.

4.10.8 MEASUREMENT

1. Sealing of cracks shall not be measured for direct payment.

2. Pavement repairs shall be measured by the sq.m of repair, prepared, filled, compacted, completed and accepted. Measurement shall be of the areas shown on the Drawings or ordered.

3. Trench reinstatements shall be measured by the sq.m of reinstatement prepared, filled, compacted, completed and accepted. Measurement shall be of the areas shown on the Drawings or ordered. New utility trench construction will not be measured under this item.

4. No separate measurement will be made for excavation, prime or tack coats or pavement materials.

5. All other incidental items shall not be measured for direct payment, as prescribed in Section 4.03 - "Bituminous Courses".

Ministry of Public Works & Housing

ERRATA 1

Page	Location	ERROR	Change
3-9	clause 1, line 3	piriorate	prior to
4-5	clause 12, line 4	25.	25%.
4-10	item 1.1, line 3	spceficiation of the Jordan standard specification	Jordan standard specification

ADDENDUM

Important

The addendum attached at the end of this book contains amendments & ERRATA .

It is recommended to fix all correction before usage .

ملاحظه :

يحتوي هذا الكتاب على ملحق بالتعديلات وجدول تصويب الاخطاء ، يرجى تثبيت كافة التصحيحات قبل الاستعمال .

ERRATA 2

Page	Location	ERROR	Change
2-26	Item 4.7 , line 10	to	two
2-26	Item 1.3 , line 5	2-28	2-27
4-6	clause 4 , line 2	Indexs	Indices
4-9	Item 3.5 , line 3	flush	flash
4-17	Item 8.1 , line 2	Types	Type
4-18	table 4.9 "Title	protection	properties
4-23	Item 3.2 , line 3	curing	setting
4-46	clause 4 , line 2	filer	filler
4-55	Item 1.3	1.3	1.2

SECTION 2.06

EMBANKMENT CONSTRUCTION

SUBSECTION 2.06.4

TESTING

clause 2

Standards of compaction for soil and granular material

Item 2.1 (page 1-26)

Amend method of testing for the relative density to be :

The relative density shall be determined in accordance with ASTM D 2049 .

SECTION 3.01

MATERIALS

SUBSECTION 3.01.3

GRANULAR MATERIAL FOR SUB-BASE

clause 4 (page 3-5)

Amend to be read as follows :

4 . The material shall contain aminimum 25% (Dry condition) when tested in accordance with AASHTO T 176 .

SECTION 3.01

MATERIALS

SUBSECTION 3.01.4

AGGREGATE FOR SUB-BASE

clause 5 (page 3-7)

Amend the last paragraph to be read as follows :

The material shall contain a minimum 35% (Dry condition) when tested in accordance with AASHTO T 176 .

SECTION 3.01
AGGREGATE BASE COURSES
SUBSECTION 3.03.7
TESTING
clause 5
Maintenance of Completed Base
Item 5.1 , Table 3.3 (page 3-18)
Amend the Repetition required in the second column to be for For every 3000 cu.m Instead of 4000 cu.m .

SECTION 3.04
STABILIZED COURSES
SUBSECTION 3.04.1
SCOPE
clause 1 (page 3-20)
Add the following at the end of the clause :

Other stabilizing approved techniques and Testing may be followed if applicable .

SECTION 4.01
MATERIALS
SUBSECTION 4.01.3
AGGREGATE FOR BITUMINOUS PAVING MIXES
clause 4 (page 4-3)
Amend the first line to be as follows :

Table 4.1: Gradation of Aggregates for Bituminous Mixes

Sieve Designation	Heavy Traffic		Medium & Light Traffic	
	Binder Course	Wearing Course	Binder Course	Wearing Course
1 1/2"	-	-	-	-
1 "	100	100	100	100
3/4"	70 - 100	90 - 100	70 - 100	90 - 100
1/2"	53 - 90	71 - 90	53 - 90	71 - 90
3/8"	40 - 80	56 - 80	40 - 80	56 - 80
No. 4	30 - 56	35 - 56	30 - 56	35 - 65
No. 8	23 - 38	23 - 38	23 - 49	23 - 49
No.20	13 - 27	13 - 27	14 - 43	14 - 43
No.50	5 - 17	5 - 17	5 - 19	5 - 19
No.80	4 - 14	4 - 14	4 - 15	4 - 15
No.200	2 - 8	2 - 8	2 - 8	2 - 8

Aggregate shall not contain gypsum more than 1% when tested

in accordance to AASHTO T 105 .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.3

AGGREGATE FOR BITUMINOUS PAVING MIXES

clause 5 (page 4-4)

Add the following at the end of the clause :

and any other deleterious substances .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.3

AGGREGATE FOR BITUMINOUS PAVING MIXES

clause 11, Table 4.4 (page 4-5)

Modify the content of the table to be as follows :

SECTION 4.01

MATERIALS

SUBSECTION 4.01.4

AGGREGATE FOR SEAL COATS

clause 2 (page 4-6)

Amend the clause to be as follows :

Aggregate shall not contain crystalline or amorphous gypsum (expressed as SO3) more than 1% when tested in accordance to AASHTO T 105 .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.6

BITUMEN GENERALLY

clause 5

SAMPLING & TESTING

Item 5.3 (page 4-10)

Add the word " Relinery " in the third line , to be read as follows " Jordan petroleum relinery company " .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.7

BITUMEN PRODUCTS

clause 5

SLOW - CURING (SC) CUTBACK BITUMEN

Item 5.1 , Table 4.7 (page 4-15)

Modify the contents of the table to be as follows :

Table 4.7: PROPERTIES OF S.C. CUTBACK BITUMEN

	SC-70		SC-250		SC-800		SC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic viscosity at 60°F cSt	70	140	250	500	800	1600	3000	6000
Flash point (Cleveland open cup), C	66	-	79	-	93	-	107	-
Distillation test:								
Total distillate to 360C, volume %	10	30	4	20	2	12	-	5
Solubility in trichloroethylene %	99.	-	99.	-	99.	-	99.	-
Kinematic viscosity on distillation residue at 60C, St	4	70	8	100	20	160	40	350
Asphalt residue:								
Residue of 100 penetration, %	50	-	60	-	70	-	80	-
Ductility of 100 penetration residue at 25C, cmWater, %	100	-	100	-	100	-	100	-
	-	0.5	-	0.5	-	0.5	-	0.5

SECTION 4.01

MATERIALS

SUBSECTION 4.01.7

BITUMEN PRODUCTS

clause 7

ANIONIC EMULSIFIED BITUMEN

Item 7.1 ; Table 4.8 (page 4-17)

Delete the foot note :

" If type of emulsion is not specified in the special technical specification slow setting shall be used " .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.7

BITUMEN PRODUCTS

clause 7

ANIONIC EMULSIFIED BITUMEN

Item 7.3

Modify the content of this item to be as follows :

7.3 Emulsified bitumen spraying temperature range shall be so that appropriate viscosity for each application is achieved , if however the viscosity curve are not available these values should be generaly as guidance 25 - 65 degree C . The temperature range for pugmill mixing shall be 15-65 degree C .

SECTION 4.01

MATERIALS

SUBSECTION 4.01.7

BITUMEN PRODUCTS

clause 8

CATIONIC EMULSIFIED BITUMEN

Item 8.1 , table 4.9 (page 4-18)

Delete the foot note :

" If type of emulsion is not specified in the special technical specification slow setting shall be used ".

SECTION 4.01

MATERIALS

SUBSECTION 4.01.7

BITUMEN PRODUCTS

clause 8

CATIONIC EMULSIFIED BITUMEN

Item 8.3 (page 4-18)

Modify the content of this item to be as follows :

8.3 Emulsified bitumen spraying temperature range shall be so that appropiate viscosity for eash application is achieved , if however the viscosity curve are not available these values should be generaly as guidance 25 - 65 degree C . The temperature range for pugmill mixing shall be 15-65 degree C .

SECTION 4.02

BITUMINOUS PRIME AND TACK COATS

SUBSECTION 4.02.2

MATERIALS

clause 3 (page 4-20)

SLOW - CURING EMULSIFIED BITUMEN

Amend the title of the clause to be as follows :

" Slow-setting Emulsified Bitumen " .

SECTION 4.03

BITUMINOUS COURSES

SUBSECTION 4.03.3

JOP MIXES AND PROTECT MIXES

clause 4 (page 4-26)

Delete the last statment " It shall also stipulate the mixing temperature at discharge from the mixer which , unless other wise , directed shall be 170 degree C .

SECTION 4.03

BITUMINOUS COURSES

SUBSECTION 4.03.3

JOB MIXES AND PROTECT MIXES

clause 8 , table 4.10 (page 4-27)

shift the word temperature in the last line to be read as follows :

" + or - 5 C of specified mixing temperature " .

SECTION 4.03

BITUMINOUS COURSES

SUBSECTION 4.03.6

MIXING PROCEDURES

clause 4 , table 4.11 (page 4-31)

Amend the content of this table to be as follows :

Table 4

Type and grade of Asphalt	Viscosity centistockes	Max temperature C immediately after discharge from pugmill
85 - 100 pen	170 + or - 20	160
60 - 70 pen	170 + or - 20	163
40 - 50 pen	170 + or - 20	163

SECTION 4.03

BITUMINOUS COURSES

SUBSECTION 4.03.9

SAMPLING AND TESTING

clause 1 , table 4.13 (page 4-40)

Amend the content of point four in the second column to be read as follows :

4. Clay lumps and friable particles

SECTION 4.03

BITUMINOUS COURSES

SUBSECTION 4.03.9

SAMPLING AND TESTING

clause 1 continuation of table 4-13 (page 4-41)

Modify the content of table 4-14 to be as follows :

Table 4.13: (Continued)

Work item	(A) Tests at Source of material	Frequency for all tests mentioned under (A)	(B) Tests at road site	Frequency for all tests mentioned under (B)
4-4 Asphalt for each layer	At Batching plant 1-Stability 2-Flow 3-Extraction (binder content and gradation) 4-Air voids 5-Voids in mineral aggregates 6-Daily Marshall density	-Test each 3 working days -Test for each batching plant -As requested	Behind spreader 1-Stability 2-Flow 3-Extraction (binder content and gradation 4-Air voids 5-Voids in mineral aggregates 6-Daily Marshall density	-Test each working day -Test for each batch -As requested
	7-Loss of Stability	-Once a week -As requested	7-Road density and thickness (after final compaction	-Test each 200 linm, per lane and for each layer -As requested
			8-Loss of stability	-Once a week -As requested

SECTION 4.03

BITUMINOUS BASE COURSES

SUBSECTION 4.04.3

JOB MIX AND PROTECT MIX

clause 2 , table 4.14 (page 4-46)

Add the word minimum in the first column after marshall stability of 60 C (kg) .

SECTION 4.05

BITUMINOUS BINDER AND WEARING COURSES

SUBSECTION 4.05.1

SCOPE

clause 1 (page 4-50)

Amend the content of this clause to be as follows :

1 - These works shall consist of furnishing materials , mixing at a central mixing plant , spreading and compacting bituminous binder course and bituminous wearing course on an approved base as and where shown on the drawing .

SECTION 4.05

BITUMINOUS BINDER AND WEARING COURSES

SUBSECTION 4.05.3

JOB MIX AND PROTECT MIX

clause 2 , table 4.15 (page 4-51)

Add the word minimum in the first column after marshall stability at 60 C (kg) .

SECTION 4.06

BITUMINOUS SEAL COATS

SUBSECTION 4.06.2

MATERIALS

clause 1 (page 4-55)

Bitumen

Item 1.3 second line

Delete the following :

" or CSS 1h " .