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ISLAMIC REPUBLIC OF PAKISTAN
NATIONAL HIGHWAY AUTHORITY

Asian Development Bank Loan No. 2742-PAK

FLOOD EMERGENCY RECONSTRUCTION PROJECTS (FERP)

(ADB/FERP/ICB-N-03)

NHA General Specification

ICB-N-03: Rehabilitation of Kohala – Muzaffarabad Road (S-2)

Package-I: Km 00 to Km 20

On Post Qualification Basis
(Single-Stage Two Envelopes)

(VOLUME-II)

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FOREWORD

Review and updating of General Specifications of National Highway Authority (1991) became essential in light of new responsibilities entrusted by the Honorable Prime Minister of Pakistan on this Agency to Construct Motorways and other important highways on international standards.

In order to assess the new requirements of General Specifications we arranged series of meetings with other consultants of the Authority, besides getting the opinions of major contractors in Highway Industry. We also consulted different Directorates of the Authority to know the problems felt by them during execution of highway projects. A seminar was also arranged to discuss various maters, which attracted representatives of various clients, consultants and contractors of highway industry in Pakistan.

We have carried out amendments in the current General Specifications looking to the causes of disputes and reasons of failure of certain roads constructed in various parts of the country. Addition of new items has also been made in the existing specifications to cater for future needs of National Highway Authority.

Our sincere thanks are due to several agencies, which contributed in compilation of this important document, however special attention of Contracts and Specifications Section of National Highway Authority under the guidance of Chairman NHA, helped us to complete the assignment successfully. We hope that this document will contribute effectively in improving the workmanship and quality of highway construction in Pakistan.

For SAMPAK International (Pvt) Ltd.,
(S.M.A. Shirazi)

NATIONAL HIGHWAY AUTHORITY
GENERAL SPECIFICATIONS

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GENERAL

1. Introduction

1.1 Preamble

General Specifications have been produced for National Highway Authority, keeping in consideration that following types of activities are being carried out in this organization:

i) Construction of Motorways, new Highways, Bridges and allied works.

ii) Rehabilitation and Improvement of existing road network.

iii) Maintenance of existing roads and structures.

All the above three aspects of construction, rehabilitation and maintenance have been covered in these General Specifications. Subsequent chapters would give a list of such items of work with an indication of their probable use, in case of the above three categories of works.

1.2 Standards

These Specifications describe the requirements and procedures for execution of work items to achieve required workmanship and quality. The materials to be used shall conform to specifications and testing procedures as per American Association of State Highway and Transportation Officials (AASHTO), the American Society for Testing and Materials (ASTM) or British Standard (B.S.) as indicated in their latest editions. Samples of materials for laboratory tests and their subsequent approval shall be utilized according to these references.

1.3 Manpower

Contractor shall also provide skilled manpower in adequate number, who can perform execution with quality and workmanship control in accordance with the requirements of the work item.

1.4 Equipment

Number and kind of Equipment required for different items of work shall be planned by the contractor keeping in view the workmanship required by a particular item and the quantity of finished item required to be carried out in eight hours shift. The Engineer shall approve such planning or any changes shall be proposed for guidance of the Contractor. However this procedure shall not relieve the Contractor of his contractual obligations pertaining to performance and maintenance of project.

1.5 **Alternative Equipment**

While few of these specifications may provide that equipment of a particular size and type is to be used to perform portions of the work, it is to be understood that the deployment and use of new or improved equipment is to be encouraged.

The Contractor may request, in writing, permission from the Engineer to use equipment of a different size or type in place of the equipment specified or recommended in these chapters.

The Engineer, before considering or granting such request, may require the Contractor to furnish, at his expense, evidence to satisfy the Engineer that the equipment proposed for use by the Contractor is capable of producing work equal to or better in quality than, that which can be produced by the equipment specified.

If such permission is granted by the Engineer, it shall be understood that such permission is granted for the purpose of testing the quality of work actually produced by such equipment and is subject to continuous attainment of results which, in the opinion of the Engineer, are equal to, or better than, that which can be obtained with the equipment specified. The Engineer shall have the right to withdraw such permission at any time when he determines that the alternative equipment is not producing work of equal quality in all respects, to that which can be produced by the equipment specified. Upon withdrawal of such permission by the Engineer, the Contractor will be required to use the equipment originally specified and shall, in accordance with the directions of the Engineer, remove and dispose off or otherwise remedy, at his expense, any defective or unsatisfactory work produced with the alternative equipment.

Neither the Employer nor the Contractor shall have any claim against the other for either the withholding or the granting of permission to use alternative equipment, or for the withdrawal of such permission.

Nothing in this clause shall relieve the Contractor of his responsibility for furnishing materials or producing finished work of the quality specified in these specifications.

1.6 **Storage of Materials**

Articles or materials to be incorporated in the work shall be stored in such a manner as to ensure the preservation of their quality and fitness for the work, and to facilitate inspection.

1.7 **Defective Materials**

All materials which the Engineer has determined as not conforming to the requirements of the drawings and specifications will be rejected whether in place or not. They shall be removed immediately from the site of the work, unless otherwise permitted by the Engineer. No rejected material, the defects of which have been subsequently corrected, shall be used in the

work, unless approval in writing has been given by the Engineer. Upon failure of the Contractor to comply promptly with any order of the Engineer made under the provisions in this clause, the Engineer shall have authority to cause the removal of rejected material and to deduct the cost thereof from any payments due or to become due to the Contractor.

1.8 Quarry Materials

Quarry material is rock, sand, gravel, earth, or other mineral material, other than local borrow or selected material, obtained on the project. Quarry material does not include materials such as cement, lime, marble powder etc. obtained from established commercial sources.

Quarry Materials shall be furnished by the Contractor from any source he may select, except that when mandatory local sources of certain materials are designated in the Special Provisions, the Contractor shall furnish material from such designated mandatory sources.

The furnishing of quarry materials from any source is subject to the provisions of "Examination of drawings, Specifications, and Item of Work".

Unless approved in writing by the Engineer, material sources shall not be excavated at locations where the resulting scars will present an unsightly appearance from any highway. No payment will be made for material obtained in violation of this provision.

The Contractor shall, at his expense, make any arrangements necessary for hauling over local public and private roads from any source.

Full compensation for furnishing all labour, materials, tools, equipment, and incidentals, and for doing all the work involved in conforming to the provisions in this clause, for furnishing and producing materials from any source shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

1.9 Trade Names and Alternatives

For convenience in designation on the plans or in the specifications, certain articles or materials to be incorporated in the work may be designated under a trade name or the name of a manufacturer and the catalogue information. The use of an alternative article or material that is of equal quality and of the required characteristics for the purpose intended will be permitted, subject to the following requirements:

The responsibility of proof as to quality and suitability of alternatives shall be upon the Contractor and he shall furnish all information necessary as required by the Engineer. The Engineer shall be the sole judge as to the quality and suitability of alternative articles or materials and his decision shall be final.

Whenever the specifications permit the substitution of a similar or equivalent material or article, no tests or action relating to the approval of such substitute material will be made until the request for the substitution is made in writing by the Contractor accompanied by complete data as to the equality of the material or article proposed. Such request shall be made well in time to permit approval without delaying the work.

1.10 **Frequency of Tests & Test Designation**

Frequency of tests for the items of construction has been given in subsequent chapters. Test designation and procedure will be used as given in the latest version of relative publication.

1.11 **Testing**

Unless otherwise specified, all tests shall be performed in accordance with the methods used by AASHTO/ASTM and shall be made by the contractor under the supervision of the Engineer or his designated representative.

Whenever the specifications provide an option between two or more tests, the Engineer will determine the test to be used.

Whenever a reference is made in the specifications to a specification manual, or a test designation either of the American Society For Testing and Materials, the American Association of State Highway and Transportation Officials, Federal Highway Specification, or any other recognized national organization, and the number or other identification representing the year of adoption or latest revision is omitted, it shall mean the specification, manual or test designation in effect on the day 30 days prior to the date for submission of bids. Whenever said specification manual or test designation provides for test reports (such as certified mill test reports) from the manufacturer, copies of such reports, identified as to the lot of material, shall be furnished to the Engineer. When material that cannot be identified with specific test reports is proposed for use, the Engineer may, at his discretion, select random samples from the lot for testing. Test specimens from the random samples, including those required for retest, shall be prepared in accordance with the referenced specification and furnished by the Contractor at his expense. The number of such samples and test specimens shall be entirely at the discretion of the Engineer. Unidentified metal products such as sheet plate, hardware, etc. shall be subject to the test requirements prescribed by the Engineer.

When desired by the Engineer, the Contractor shall furnish, without charge, samples of all materials entering into the work and no material shall be used prior to approval by the Engineer. Samples of material from local sources shall be taken by or in the presence of the Engineer, otherwise the samples will not be considered for testing.

1.12 **Construction Stakes, Lines and Grades**

The Engineer will furnish design survey data and jointly locate with contractor, all points of intersection and of tangents and basic benchmarks. The plans indicate the properties of horizontal and vertical curves, together with rates of superelevation where required. The contractor shall set

construction stakes establishing lines, slopes, and continuous profile-grade in road work, and center line and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances and will furnish the Engineer with the original copy of the field notes together with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work.

If, in the opinion of the Engineer, modification of the line or grade is advisable, before or after stakeout, the Engineer will issue detailed instructions to the Contractor for such modification and the Contractor will revise the stakeout for further approval. No change in bid unit price will be made for such modifications.

The profiles and cross sections on the plans indicate the elevation of the top of road surface or as otherwise noted on the plans. The contractor shall be responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks has been destroyed or disturbed, the Contractor will replace them at his own expense.

The Contractor shall be responsible for the accuracy of all lines, slopes, grades, and other survey work.

1.13 **As-Built Drawings/Shop Drawings**

During construction, the Contractor shall keep an accurate record of all deviations of work as actually installed from that shown or indicated on the Contract Drawings or revised during construction. Upon completion of the Works, the Contractor shall deliver all "As Built" drawings to the Engineer.

All shop drawings/fabrication drawings shall be prepared by the Contractor and submitted to the Engineer before the start of the work. The Engineer shall check and approve or return the same to the Contractor for correction/modification. All works are to be executed in accordance with shop drawings, approved before the commencement of the works. Shop drawings should truly reflect the provisions of typical drawings. Any deviation from the provision of contract drawings, shall not be allowed unless written approval is issued by the Engineer.

1.14 **Utility Lines**

The Contractor shall conduct his operations, make necessary arrangements, take suitable precautions and perform all required works incidental to the protection of and avoidance of interference with power transmission, telegraph, telephone and natural gas lines, oil lines water and sewerage mains and other utilities within the areas of his operations in connection with his contract and the Contractor shall save harmless and indemnify the Employer in respect of all claims, demands, proceedings, costs, charges and expenses whatsoever arising out of or in relation to any such interference.

1.15 **Safety Precautions.**

The Contractor shall adequately provide for the safety, health and welfare of persons and for the prevention of damage to works, materials and equipment for the purpose of or in connection with the Contract.

1.16 **Inspection**

The Engineer shall, at all times, have safe access to the work during its construction, and shall be furnished with every reasonable facility for ascertaining that the materials and the workmanship are in accordance with the requirements and intentions of these Specifications, the Special Provisions, and the plans/drawings. All works done and all materials furnished shall be subject to inspection by Engineer.

The inspection of the work or materials shall not relieve the Contractor of any of his obligations to fulfill his contract as prescribed. Work and materials not meeting such requirements shall be made good and unsuitable work or materials may be rejected, not withstanding that such work or materials have been previously inspected by the Engineer or that payment therefor has been included in a progress estimate.

1.17 **Removal of Rejected and Unauthorized Work**

All works, which have been rejected, shall be remedied, or removed and replaced by the Contractor in an acceptable manner and no compensation will be allowed to him for such removal, replacement, or remedial work.

Any work done beyond the lines and grades shown on the plans or established by the Engineer, or any extra work done without written authority will be considered as unauthorized work and will not be paid for.

Upon order of the Engineer, unauthorized work shall be remedied, removed, or replaced at the Contractor's expenses.

Upon failure of the Contractor to comply promptly with any order of the Engineer made under this Item, the Employer may cause rejected or unauthorized work to be remedied, removed, or replaced and to deduct the costs from any payment due or to become due to the Contractor.

1.18 **Alternative Methods of Construction**

Whenever the plans or specifications provide that more than one specified methods of construction or more than one specified type of construction equipment may be use to perform portions of the work and leave the selection of the method of construction or the type of equipment to be used up to the Contractor. it is understood that the Employer does not guarantee

that every such method of construction or type of equipment can be used successfully throughout all or any part of any project. It shall be the Contractor's responsibility to select and use the alternative or alternatives, which will satisfactorily perform the work under the conditions encountered.

In the event some of the alternatives are not feasible or it is necessary to use more than one of the alternatives on any project, full compensation for any additional cost involved shall be considered as included in the contract price paid for the item of work involved and no additional compensation will be allowed thereof.

1.19 **Conformity with Contract Documents and Allowable Deviations.**

Work and materials shall conform to the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the specifications. Although measurement, sampling and testing may be considered evidence as to such conformity, the Engineer shall be the sole judge as to whether the work or materials deviate from the plans and specifications, and his decision relating to any allowable deviations therefrom shall be final.

1.20 **Trial Section**

Contractor shall submit complete methodology of trial section for approval of the Engineer. Trial sections shall be prepared for each type of road pavement layer. Inspite of the approval of Engineer for trial section, contractor shall be responsible for the quality of work. Contractor will provide minimum of following informations in the methodology.

i) Equipment to be used.
ii) Layer thickness adopted
iii) Per day production.
iv) Results of tests.

2. **Scope**

The Standard Specifications is a part of contract documents which shall be read in conjunction with the following contract documents which are mutually explanatory to one another and mentioned hereunder, with the order of precedence as given in the Condition of Contract.

(i) Contract Agreement.
(ii) Instruction to bidders.
(iii) Addenda.
(iv) Letter of acceptance.
(v) Supplementary conditions.
(vi) Special Provisions.
(vii) Conditions of Contract Part - II.
(viii) Conditions of Contract Part - I.
(ix) Drawings.
(x) General Specifications.
(xi) The bid and Appendices "A to L".

3. **Abbreviations and Definitions**

Wherever in these specifications or in other contract documents the following abbreviations and terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

3.1 Abbreviations

AASHTO	-	American Association of State Highway and Transportation Officials.
ASTM	-	American Society for Testing and Material
AWG	-	American Wire Gauge
AWPA	-	American Wood Preservers Association
BS	-	British Standard Code of Practice
ACI	-	American Concrete Institute
FHWA	-	U.S. Federal Highway Administration
PCA	-	Portland Cement Association
Wt.	-	Weight
Lb.	-	Pound
AWS	-	American Welding Society
Gallon	-	U.S. Gallon
In.	-	Inch
Ft.	-	Foot
Yd.	-	Yard
Ltr.	-	Litre
mm	-	Millimeter
cm.	-	Centimeter
M	-	Meter
Km	-	Kilometer
SM	-	Square Meter
o	-	degree
Sq. cm.	-	Square Centimeter
CM	-	Cubic Meter
ha	-	Hectare
Kg	-	Kilogram
Ton	-	Metric Ton (1000 Kg)
^oC	-	Degree Centigrade
^oF	-	Degree Fahrenheit

1.2 Definitions

Wherever in these specifications or in other contract document the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

Accepted

- Completion of the work item to the Engineer's satisfaction

Addendum

- A written amendment or revision to the Contract documents or plans issued to bidders prior to the final date and time for submission of Tenders in the "Instruction to Tenderer."

Aggregates

- Crushed stone or processed gravel (shingle)

Amenities

- Recreational facilities and similar items provided to improve living conditions at site - characteristics conducive to pleasantness.

Apron

- A concrete, rock or masonry slab forming a part, or for the protection of a structure.

Asphalt Base Course

- The lowermost layer of specified thickness of an asphalt concrete pavement which may include an asphalt leveling course.

Asphalt Concrete

- High quality, thoroughly controlled hot mixture of asphalt cement and well-graded, high quality aggregate, thoroughly compacted into a uniform, dense mass.

Asphalt Concrete Pavement

- All courses of asphalt-aggregate mixtures placed above the layer of base course, subbase or improved subgrade. When placed directly on the subgrade, it is called full-depth asphalt pavement.

Auxiliary Lane

- That portion of the roadway adjoining the traveled way for speed change or other purposes supplementary to through traffic movements.

Barrage

- A low dam or weir across a river equipped with a series of gates to regulate the water surface level above the weir.

Base Course

- The layer of specified material and thickness placed immediately below the surfacing.

Batten

- Beam, structural member.

Beldar

- Unskilled labour employed on maintenance gangs for canals or roads.

Bid/Tender Price

- The sum of the products of the quantities of work with the quoted prices in the Tender by the Contractor.

Bill of Quantities and list of Prices

- A list showing work quantities and specifying unit price and/or lump sum for specific items of work.

Blinding Layer

- A layer of concrete or other material (Generally thin) covering the surface of excavated ground or fill, forming a stable surface on which further work may be constructed.

Boulder

- A rock fragment, usually rounded by weathering or abrasion, with an average dimension of 10 centimeters or more.

Boundary

- Limit of right-of-way or other zones.

Bridge

- Any structure other than a culvert, which carries a utility, facility, or railroad highway, pedestrian, or other traffic over a water course, over, under or around any obstruction and with a clear span of more than 6.50 M.

Bund

- A continuous embankment, dike or levee. (generally associated with training or containing the flow of rivers).

Catchment

- The watershed or area which contributes runoff to a drain or other channel.

Contractor

- The individual firm or corporation contracting with the Employer/Client for performance of the prescribed work.

Contract Price

- The sum of the products of the quantities with the agreed prices appearing in the agreement between the Contractor and the Engineer/Employer.

Construction Limit

- Construction limit of a project is area between left & right side of catch points of road under construction, where as in case of structures this limit will extend to area which is required for execution of permanent structure

Cubic Meter

- A volume equivalent to 1.0 M x 1.0 M x 1.0 M.

Cuboid

- Crushed stone particles with each face fractured and in roughly cuboid shape.

Culvert

- Any structure, other than a bridge which provides an opening under a roadway for drainage or irrigation proposes and with a clear span of 6.5 M or less.

Cum

- With or associated with - for example, 'Railroad-cum-road' bridge.

Cusec

- A rate of flow of one cubic foot per second.

Daywork

- Work to be paid for on the basis of actual labour, material, and plant used - Force account.

Detour (Diversion)

- A temporary roadway, which leaves the main, route and rejoin it later, for the uninterrupted flow of traffic.

Drawings

- The approved plans(drawings), profiles, typical cross-sections, revised drawings and supplemental drawings, or exact reproduction thereof, which show the location, character, dimensions and details of the work.

Earth

- Sediments or other unconsolidated accumulations of solid particles, produced by the physical and chemical disintegration of rock, and which may or may not contain organic matter.

Engineer

- The duly authorized representative of the Client/Employer for controlling the project site, acting directly or through his duly authorized representatives, who is responsible for engineering supervision of the work.

Equipment

- All machinery and equipment, together with the necessary supplies for up keep and maintenance and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

Fix

- Any item of construction which requires special placement in the works.

Flexible Pavement Structure

- Any combination of improved subgrade, subbase, base and asphalt surfacing placed on the subgrade to support the traffic load and reduce its intensity at the subgrade surface.

Forms or Formwork

- Shuttering including supports and falsework.

Frustration of a Contract

- Rendered impossible of performance by external cause beyond the contemplation of the parties.

Gang Header

- Experienced workman or labour incharge of small groups of workmen or labour.

Gasoline

- Motor spirit, petrol.

Godown

- Warehouse, store room or storage shed.

Grade

- The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal center-line of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Gravel

- Small sized stone, shingle or rock fragments usually rounded in shape formed from rocks or boulders by glacial or weathering action..

Guide Bank (for Bund)

- A protective and training embankment or levee for directing river flow.

Highway

- A general term denoting public way for purposes of vehicular travel, including the entire area within the right-of-way. (Recommended Usage: in urban areas-highway or street; in rural areas-highway or road).

Install

- To place in special position any hardware, equipment or fixture for completing a job.

Kilometer

- A distance equal to 1000 meters.

Laboratory

- A testing laboratory approved by NHA or any testing laboratory, which may be designated by the Engineer.

Leveling Course

- The layer of specified material of variable thickness placed generally on an existing road surface to compensate for depressions and undulations in order to correct grades and cross falls according to design.

Materials

- Any substance specified for use in the construction of the project and its appurtenances.

Metalled (roadway)

- Surfaced, paved (roadway).

Mile

- Distance of 5,280 feet. (1,610 M)

Monsoon

- Prevailing winds in the Indian Ocean.
- The rainy season associated with the south-west monsoon.

Motor Spirit

- Petrol, gasoline.

Octroi

- A municipal fee for municipal services.

Period of Maintenance

- Period of maintenance shall mean the period of contractor's maintenance named in the contract, calculated from the date of completion of the work as certified by the Hand-over committee.

Pitching or Rip-Rap

- Broken stone, brickwork or other materials placed usually on side slopes of Embankments for protection of the earth surface, dry or in cement mortar as specified.

Prime Cost

- A net sum entered in the Bill of Quantities by the employer as the sum provided to cover the cost of or to be paid by the Contractor to merchants or others for specific articles or materials to be supplied after deducting all trade discounts and any discount for cash.

Provide

- *To make available* an item for a certain period/time or indefinite time as the case may be.

Provisional Sum

- Any sum of money fixed by the Employer and included in the Bill of Quantities to provide for work not otherwise included therein. A provisional sum is only to be expended, either wholly or in part under the Employer's Representatives or the Engineer's direction in accordance with Contract. This sum may or may not be utilised in full or partially through the contractor.

Regulator

- A canal structure, usually equipped with gates, for control, or checking, of flow in the canal or an off taking channel.

Return

- Report

Revetment (Material)

- Rock.

Right-of-way (ROW)

- A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

Roadside

- A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

Roadway

- *The portion of a highway within limits of construction.*

Scaffolding

- Arrangement of struts/columns/pipes to support shuttering or other platforms.

Setting out

- Laying out or staking out-establishing on the site the lines, levels and grades to which the construction works are to be carried out.

Shingle

- See Aggregates.

Shoulders

- The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Sidewalk

- That portion of the roadway primarily constructed for the use of pedestrians.

Sleepers

- Cross ties, railroad ties.

Soil Binder

- Portion of Soil passing 0.425 mm (# 40) sieve.

Special Provisions

- Additions and revisions to the Standard Specifications and General Conditions of Contract, covering conditions particular to an individual contract.

Spoil Bank

- Disposal area for excess excavation, spoil tip or waste dump.

Structures

- Bridges, culverts, catch basins, drop inlets retaining walls, manholes, headwalls, service pipes causeways Irish bridges and other features which may be encountered in the work and not otherwise classed herein.

Subbase

- The layer of specified material and thickness placed between the base course and subgrade.

Subgrade

- The top surface of a roadbed upon which the pavement structures and shoulders including curbs are constructed.

Subgrade level

- That level of the roadbed (or, embankment) on which other road material has to be placed.

Subgrade treatment

- Modification of roadbed material by stabilization.

Substructure

- All of that part of a structure below the bearings of simple and continuous spans, or rigid frames, including back walls, wing walls.

Super-tax

- A Pakistani tax on income or profit above a certain level of income or profit.

Surface Course

- The uppermost layer of specified thickness of an asphalt concrete pavement; also called "Wearing Course".

Surfacing

- The uppermost layer of specified material placed on the traveled way or shoulder. Types of surfacing may consist of surface treatment (hot surface dressing), of asphalt concrete surface course, or concrete pavement.

Supply

- Primarily meaning to deliver any item on permanent basis.

Tender

- Bid proposal.

Tenderer

- A firm or individual submitting a Tender.

Traffic Lanes

- That portion of a traveled way allowing the movement of a single line of vehicles.

Unmetalled (Roadway)

- Unsurfaced, unpaved (roadway)/dirt road.

Variation Order

- A document compiled to include changes, substitutions and additional work items not covered in the B.O.Q, for the sanction of the competent Authority and shall include increase or decrease in quantities or rates also.

Work

- The work shall mean the furnishing of all labour, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and carrying out of all the duties and obligations imposed by the contract.

Wagon (railway)

- A railroad freight car.

Wayleave

- Permission to cross land, right of entry as defined in the land acquisition act of the Government of Pakistan.

Well

- A concrete or masonry caisson incorporated in foundations.

Working Drawings

- Stress sheets, shop drawings, erection plans, falsework plans, form work plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the contractor is required to submit to the Engineer for approval.

Written Undertaking

- A written promise.

TABLE FOR SAMPLING

AND

TESTING FREQUENCY

SCHEDULE FOR SAMPLING AND TESTING OF EMBANKMENT AND SUBGRADE (ITEM NO. 108 TO 113)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Soil	Classification.	AASHTO M-145	1/2,000 CM.	As per Item 108.2, 109.2.5, 110.2 etc.
	CBR	AASHTO T-193	1/2,000 M.	As per Item 108.2 and 110.2 etc.
	Swelling	AASHTO T-193	1/2,000 CM.	As per Item 108.2 (c)
	Moisture Density (Lab) or Relative Density.	AASHTO T-180 ASTM D-4254-83	1/2,000 M. 1/1,000 M.	As per Item 108.3, 109.2.2 etc ref. Density
	Field Density.	AASHTO T-191	1/200 M.	As per Item 108.3, 109.2.2 etc.

SCHEDULE FOR SAMPLING AND TESTING OF GRANULAR SUBBASE (ITEM NO. 201)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Aggregate	Gradation	AASHTO T-27	3/Source plus 1/1000 CM	As per Item No. 201.2
	Plasticity Index.	AASHTO T-89 and T-90	3/Source plus as required base on visual observation.	- do -
	CBR	AASHTO T-193	3/Source plus as required based on variation in gradation or 1/1000 CM	- do -
	Abrasion	AASHTO T-96	3/Source plus 1/500 CM	- do -
	Moisture Density.	AASHTO T-180	1/1000 CM	- do -
	Field Density	AASHTO T-191, T-238 and T-239	4/layer/400 M laid, 3 Minimum/layer if less than 400 M laid.	As per Item No. 201.3.4.
	Sand Equivalent	AASHTO T-176	3/source plus as required based on visual observation.	As per Item No. 201.2

SCHEDULE FOR SAMPLING AND TESTING OF AGGREGATE BASE COURSE (ITEM NO. 202)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Aggregate	Gradation	AASHTO T-27	3/Source plus 1/1000 M	As per Item 202.2 (a)
	Plasticity Index.	AASHTO T-89 and T-90	3/Source plus as required based on visual observation.	As per Item 202.2 (e)
	CBR	AASHTO T-193	3/Source/stock pile plus as required base on variation in gradation.	As per Item 202.2 (f)
	Abrasion	AASHTO T-96	3/Source plus 1/5,000 CM	As per Item 202.2 (c)
	Sodium Sulphate Soundness	AASHTO T-104	3/Source plus 1/5,000 CM	As per Item 202.2 (d)
	Fractured faces.	Visual	3/Source plus as required based on visual observation.	As per Item 202.2 (b)
	Moisture Density.	AASHTO T-180	1/1000 CM	As per Item 203.3.3.
	Field Density.	AASHTO T-191 or T-238 and T-239.	4/layer/400 M laid 3 minimum/layer if less than 400 M laid.	As per Item 202.3.3.
	Sand Equivalent	AASHTO T-176	3/source plus as required based on visual observation.	As per Item 202.2(e)

SCHEDULE FOR SAMPLING AND TESTING OF ASPHALTIC BASE COURSE PLANT MIX (ITEM NO. 203)

Material	Test	Designation	Sampling and Testing Frequency.	Reference
Coarse Aggregate	Gradation	AASHTO T-27	1/1000 CM	
	Abrasion	AASHTO T-96	3/Source/stock pile plus 1/5000 CM	As per Item 203.2.1 (a)
	Sodium Sulphate Soundness	AASHTO T-104	3/Source plus 1/5000 CM	As per Item 203.2.1 (b)
	Stripping	AASHTO T-182	3/Source plus 2/5000 CM	--
	Fractured faces	Visual	3/Source plus as required based on visual observation.	As per Item 203.2.1
	Flat and Elongated Particle.	Visual	" " "	As per Item 203.2.1 (e)
	Specific Gravity. and Absorption	AASHTO T-85	4/Source for each size in Hot bins of Asphalt Plant	For use in preparation of JMF.
Fine Aggregate	Sand Equivalent or	AASHTO T-176	3/Source plus as required based on visual observation.	As per Item 203.2.1 (c)
	Plasticity Index.	AASHTO T-89 and T-90.	2/1000 CM	As per Item 203.2.1 (d)
	Specific Gravity.	AASHTO T-84	4/Source.	For use in preparation of JMF.
	Friable Particles	AASHTO T-112	2/5000 CM	--
Asphalt Cement.	Specific Gravity.	AASHTO T-228	2/Shipment.	For use in preparation of JMF.
	Penetration.	AASHTO T-49	3/Week of plant operation Samples taken from heating tank at staggered intervals.	As per Item 203.2.2.
Mixture	Extraction	AASHTO T-164	2/day's production.	As per Item 203.2.3.
	Gradation	T-30		
	Bulk Sp. Gr	AASHTO T-166 Method B		
	Maximum Sp. Gr.	AASHTO T-209		
	Air Voids	AASHTO T-269		

SCHEDULE FOR SAMPLING AND TESTING OF ASPHALTIC BASE COURSE PLANT MIX (ITEM NO. 203)

Material	Test	Designation	Sampling and Testing Frequency.	Reference
Mixture Compacted in place.	Thickness	AASHTO T-230	1/layer @ 100 M interval per lane.	As per item 203.3.11.
	Compaction	AASHTO T-230 ASTM D2950	1/layer @ 100 M interval per lane.	As per item 203.3.9

Notes:

Test locations will be selected at random.

SCHEDULE FOR SAMPLING AND TESTING OF SOIL-CEMENT BASE COURSE (ITEM NO. 204)

Material	Test	Designation	Sampling and Testing Frequency.	Reference
Soil	Classification.	AASHTO T-27 and T-89.	3/Borrow Source plus 1/1000 CM	Soil Class must be A-3 or A-4.
Mixture	Moisture- Density.	AASHTO T-134	1/Soil Class.	As per Item 204.3.4 for ref. Density
	Pulverization.	Note.(a)	1/300 m strip	–
	Field Density.	AASHTO T-191 or T-238 & T-205.	1/300 m strip 1/300 m strip	As per Item 204.3.5.
	Compressive Strength	ASTM D-1633	1/Soil Class	As per Item 204.2.4
	Wetting & Drying	AASHTO T-135	1/Soil Class	For mix design.

Note:

a) Screening of Soil through one inch and No. 4. sieves prior to mixing with cement.

SCHEDULE FOR SAMPLING AND TESTING OF CRACK-RELIEF LAYER (ITEM NO. 205)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Aggregate (Crushed)	Gradation	AASHTO T-27	Same as for item 202.	As per Item 205.2.1.
Aggregate (Asphaltic open-graded plant mix)	Gradation	AASHTO T-27	Same as for coarse aggregate under item 203.	As per item 205.2.1.
Asphalt Cement	–	–	Same as for Item 203.	As per Item 203.2.2.
Mixture	Asphalt Coating.	AASHTO T-195	1/day's production or as required based on visual observation.	–

SCHEDULE FOR SAMPLING AND TESTING OF WEARING COURSE PLANT MIX (ITEM NO. 305)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Coarse Aggregate	Gradation	AASHTO T-27	1/1000 CM	
	Abrasion.	AASHTO T-96	3/Source plus 1/5000 CM	As per Item 305.2.1 (a)
	Sodium Sulphate Soundness	AASHTO T-104	3/Source plus 1/5000 CM	As per Item 305.2.1 (b)
	Stripping	AASHTO T-182	3/Source plus 1/5000 CM	
	Fractured faces	Visual	3/Source plus as required base on visual observation.	As per Item 305.2.1
	Flat and Elongated Particle.	Visual	- do -	As per Item 305.2.1 (e)
	Specific Gravity and Absorption.	AASHTO T-85	4/Source for each size in Hot bins of Asphalt Plant.	For use in preparation of JMF.
Fine Aggregate	Sand Equivalent or	AASHTO T-176	3/Source plus as required base on visual observation.	As per Item 305.2.1 (c)
	Plasticity Index.	AASHTO T-89 & T-90.	1/1000 CM	As per Item 305.2.1 (d)
	Specific Gravity.	AASHTO T-84	2/Source	For use in preparation of JMF.
	Friable Particles	AASHTO T-112	1/5000 CM	–
Asphalt Cement.	Specific Gravity.	AASHTO T-228	2/shipment.	For use in preparation of JMF.
	Penetration.	AASHTO T-49	3/week of plant operation. Samples taken from heating tank at staggered intervals.	As per clause 305.2.2
Premix Asphalt	Extraction	AASHTO T-164		
	Gradation	AASHTO T-30		
	Flow	AASHTO T-245		
	Stability	AASHTO T-245	2/day's production.	As per Clause 305.2.3
	Bulk Sp. Gravity	AASHTO T-166		
	Loss Stability	AASHTO T-245		

SCHEDULE FOR SAMPLING AND TESTING OF WEARING COURSE PLANT MIX (ITEM NO. 305)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Mixture compacted in place	Thickness	AASHTO T-230	1/layer @ 100 M interval per lane.	As per item 305.3.2.
	Compaction	AASHTO T-230 ASTM D2950	1/layer @ 100 M interval per lane.	As per Item 305.3.2.

Notes

Test locations will be selected at random.

SCHEDULE FOR SAMPLING AND TESTING OF CONCRETE
(ITEM NO. 401)

Material	Test	Designation	Sampling and Testing Frequency	Acceptance Limit.
Coarse Aggregate	Gradation	AASHTO T-27	2/Stockpile plus 1/1000 CM	As per Item 401.2.3
	Unit Wt.	AASHTO T-19	1/Source plus 1/1000 CM	For use in preparation of mix design.
	Sp. Gravity	AASHTO T-85	2/Source plus 1/1000 CM	- do -
	Absorption	AASHTO T-85	1/Source plus 1/500 CM	- do -
	Abrasion	AASHTO T-96	1/Source plus 1/5000 CM	As per Item 401.2.3
	Soundness	AASHTO T-104	1/Source plus 1/5000 CM	As per Item 401,2.3
	Deleterious Substance	AASHTO M-80	1/Source plus 1/5000 CM	As per Item 401.2.3
Fine Aggregate	Gradation	AASHTO M-6	2/Source plus 1/1000 CM	As per Item 401.2.2
	Unit Wt.	AASHTO T-19	4/Source plus 1/800 CM	For use in preparation of mix design.
	Specific Gravity	AASHTO T-84	4/Source plus 1/1000 CM	- do -
	Absorption	AASHTO T-84	1/Source plus 1/1000 CM	- do -
	Organic Impurities	AASHTO T-21	1/Source plus 1/1000 CM	As per Item 401.3.9 and 401.2.2
	Soundness	AASHTO T-104	1/Source plus 1/5000 CM	–
	Fineness	AASHTO M-6	1/Source plus 1/1000 CM	As per Item 401.2.2
	Deleterious Substance	AASHTO M-6	1/Source plus 1/5000 CM	As per Item 401.2.2
	Petrographic	–	1/Source plus 1/5000 CM	–

SCHEDULE FOR SAMPLING AND TESTING OF CONCRETE
(ITEM NO. 401)

Material	Test	Designation	Sampling and Testing Frequency.	Acceptance Limit.
	Yield Test for Cement Content	AASHTO T-121	1/Lot or 1000 Bags	As per Item 310.3.3
Cement	Setting Time	AASHTO T-131	1/Lot or 1000 Bags	As per Item 401.2.1
	Mortar Strength	AASHTO T-132	1/Lot or 1000 Bags	As per Item 401.2.1
Water	Chemical Tests	AASHTO T-26	1/Source	As per Item 401.2.7
Concrete mix	Compression (Cube or Cylinder)	AASHTO T-22	6/Shift or 50 CM (2 sets of 3 each)	As per Item 401.1.1 table 401-1
	Slump	AASHTO T-119	2/shift or 50 CM	- do -

TABLE FOR ALLOWABLE TOLERANCES
(EARTHWORKS, PAVEMENT COURSES AND CONCRETE)

Description	Thickness (mm)	Level (mm)	5M Straight-edge (mm)	Cross-fall (%)	Longitudinal Grade in 30.M (%)
Sub-grade	± 20	+ 0 - 40	30	± 0.5	± 0.1
Subbase (Granular or Stabilized)	+ 10 - 20	+ 0 - 25	20	± 0.3	± 0.1
Base Course (Granular or Stabilized)	+ 5 - 10	+ 5 - 10	6	± 0.2	± 0.1
Asphaltic Base Course.	+ 3 - 10	+ 3 - 10	6	± 0.2	± 0.1
Asphaltic Wearing Course.	± 3	± 3	5	± 0.2	± 0.1
Concrete for Pavements.	+ 10 - 5	+ 10 - 5	5	± 0.2	± 0.1
Concrete for structures	± 5	± 10	5	---	--

Note:

1. Material for stabilization of soil may be cement, lime or bitumen.
2. Accumulative tolerance shall not be more than that as specified against the final layer.

ALLOWABLE TOLERANCE FROM THEORETICAL WEIGHTS (REINFORCEMENT) AS PER AASHTO M-31

Diameter of Bars	* Lot under	Individual Bar under
All	3.5 %	6%

* The term "Lot" means all bars of the same nominal weight per linear meter contained in an individual shipping release or shipping order.

Note: Reinforcing bars are evaluated on the basis of nominal weights. In no case shall the overweight of any bar or lot of bars be cause of rejection.

TABLE FOR ALLOWABLE TOLERANCE
(REINFORCED CONCRETE PIPES OF CLASS - II AND IV)
AS PER AASHTO M-170

Description	Internal diameter variation (%)	Wall Thickness	Permissible Variation in the Position of Reinforcement
Pipes of internal diameter of 300 mm to 610 mm	± 1.5	- 5 mm or - 5 percent Whichever is less	± 10 percent of wall thickness or ± 12 mm. whichever is less
Pipes of internal diameter of 690 mm to 2750 mm	± 1.0	- 5 mm or - 5 percent Whichever is less	± 10 percent of wall thickness or ± 12 mm. whichever is less

Notes:

1. Pipe having localized variations in wall thickness exceeding those specified above shall be accepted, if the three-edge bearing strength and minimum steel cover requirements are met.

2. Pipes having variations in the position of the reinforcement exceeding those specified above shall be accepted if the three-edge bearing strength requirements on a representative sample are met.

EARTH WORK AND ALLIED ACTIVITIES

Item No	Description	New Construction	Rehabilitation	Maintenance
100 -	General, Earth Work.	o	o	o
101 -	Clearing and Grubbing.	o		
102 -	Removal of Trees.	o		
103 -	Stripping.	o		
104 -	Compaction of Natural Ground.	o		
105 -	Roadway and Borrow Excavation.	o		
106 -	Excavation of Unsuitable surplus material.	o		
107 -	Structural Excavation and Backfill.	o	o	
108 -	Formation of Embankment.	o	o	o
109 -	Subgrade Preparation.	o	o	
110 -	Improved Subgrade.	o		
111 -	Soil Cement Stabilized Subgrade.	o		
112 -	Lime Stabilized Subgrade.	o		
113 -	Bitumen Stabilized Subgrade.	o		
114 -	Dressing and Compaction of Berms.		o	o
115 -	Reinstatement of shoulders from Brick Kiln material.		o	o

SECTION-II

SUBBASE AND BASE.

Item No	Description	New Construction	Rehabilitation	Maintenance
200 -	General.	o	o	o
201 -	Granular Subbase.	o	o	o
202 -	Aggregate Base Course.	o	o	o
203	Asphaltic Base Course Plant Mix.	o	o	
204 -	Soil Cement Stabilized Subbase and Base.	o	o	
205 -	Crack Relief layer.		o	o
206 -	Water Bound Macadam Base.	o	o	o
207 -	Deep Patching.		o	o
208 -	Reinstatement of Road Surface.		o	o
209 -	Scarification of Existing Road/ Breaking of Road Pavement Structure.		o	o
210 -	Pavement Widening and Grooving of existing surface.		o	o
211 -	Lime Stabilized Aggregate Base Course.	o		
212	Bitumen Stabilized Subbase or Base.	o	o	
213 -	Cold Recycling of Road Pavement Structure/Soil Stabilisation.		o	
214 -	Asphaltic Base / Binder Course		o	
215 -	Geotextiles	o		

SURFACE COURSES AND PAVEMENT.

Item No	Description	New Construction	Rehabilitation	Maintenance
300 -	General.	o	o	o
301 -	Asphaltic Materials.	o	o	o
302 -	Bituminous Prime Coat.	o	o	o
303	Bituminous Tack Coat.	o	o	o
304 -	Bituminous Surface Treatment and Seal Coat.	o	o	o
305 -	Asphaltic Concrete Wearing Course, Plant Mix.	o	o	
306 -	Shoulder Treatment.	o	o	o
307 -	Bit-Mac.		o	o
308 -	Hot Recycling of Asphalt Concrete		o	
309 -	Cold Milling		o	o
310 -	Concrete Pavements.	o	o	o

STRUCTURES

Item No	Description	New Construction	Rehabilitation	Maintenance
400 -	General - Structures.	O	o	o
400A -	Bridges and Culverts.	O	o	
401 -	Concrete.	O	o	o
402 -	Falsework & Centring for Bridges	o	o	o
403 -	Formwork.	o	o	o
404	Steel Reinforcement.	o	o	o
405 -	Prestressed Concrete Structures.	o		
406 -	Joints & Bearing Devices for Concrete	o	o	
407 -	Piling.	o		
408 -	Sheet Piling.	o		
409 -	Well Foundation	o		
410	Brick Masonry	o	o	o
411 -	Random and. Dressed Uncoursed Stone Masonry.	o	o	o
412 -	Dressed Coursed Stone Masonry.	o	o	
413 -	Steel Structures.	o	o	

DRAINAGE AND EROSION WORKS.

ITEM NO		DESCRIPTION	New Construction	Rehabilitation	Maintenance
500	-	General - Drainage & Erosion Works.	o	o	o
501	-	Reinforced Concrete Pipe Culverts	o	o	o
502	-	Bed to Concrete Pipe Culverts.	o	o	o
503	-	Underdrain.	o	o	
504	-	Headwalls, Wingwalls, Parapets, Approach Slabs, Aprons and siphon inlets / outlets.	o	o	o
505	-	Manholes.	o	o	o
506	-	Drop Inlets and Catch Basins.	o	o	o
507	-	Gabions	o	o	o
508		Brick Paving.	o	o	o
509	-	Riprap and Reinforced Concrete Slope Protection.	o	o	o
510	-	Dismantling of Structures and Obstructions.	o	o	o
511	-	Stone Pitching.	o	o	o
512	-	Ditch Lining and Wash Checks.	o	o	o

SECTION-VI

ANCILLARY WORKS.

Item No	Description	New Construction	Rehabilitation	Maintenance
600 -	General - Ancillary Works.	o	o	o
601 -	Concrete Kerbs, Gutters and Channels.	o	o	o
602 -	Asphalt Concrete and Cement Concrete Side Walk.	o	o	o
603 -	Brick Edging.	o	o	o
604 -	Metal Beam Guard-rail.	o	o	o
605 -	Concrete Beam Guard-rail.	o	o	o
606 -	Bridge Railing.	o	o	o
607 -	Traffic Signs and Safety Devices.	o	o	o
608 -	Pavement Marking.	o	o	o
609 -	Reflectorized Pavement Studs.	o	o	o
610 -	Precast Concrete Posts & Markers.	o	o	o
611 -	Fencing.	o		
612 -	Furnishing and Planting Trees, Shrubs and Ground cover.	o	o	o
613 -	Sprigging and Sodding.	o	o	o

MISCELLANEOUS

Item No	Description	New Construction	Rehabilitation	Maintenance
701 -	Provision of Survey Teams and Instruments.	o	o	
702 -	Provide, Equip and Maintain Office Facility to the Engineer. (Base Camp Facility)	o	o	
703 -	Provide, Equip and Maintain Laboratory for the Project.	o	o	o
704 -	Maintenance of Works for One Year after completion (Period of Maintenance.)		o	o
705 -	Temporary Road Works for Traffic Diversion.		o	o
706 -	Control and Protection of Traffic.		o	o

EARTH WORK

AND

ALLIED ACTIVITIES

EARTHWORK

ITEM 100 GENERAL

100.1 DESCRIPTION

Earthwork will consist of all necessary work for the excavation and placing in embankment or backfill or disposal by dumping of earth, rock or other material from or to the roadway or adjacent thereto or from borrow areas, including the excavation of side and interception ditches, the removal of unsuitable subgrade material, the formation of laybyes, the widening of cuts and the flattening of cut slopes whether to obtain material for embankments or backfill, or to increase the stability of the slopes, clearing and grubbing, the selective removal of trees, stripping and the removal of existing obstructions within the approved cross section for excavation, in accordance with these specifications and in conformity with the lines, grades, sections, and dimensions shown on the drawings or as directed by the Engineer.

100.2 SOIL INFORMATION

Any information concerning the properties of the soil or sub soil and other geotechnical information shown on the drawing or other documents forming part of the contract is for information only. The contractor is obliged to make his own assessment of site conditions prevailing. No claim for extra cost or time extension will be entertained based on the information provided.

The Contractor shall be deemed to have visited the site prior to making his bid and shall ascertain the nature of the earth and rock, its quantity, locations and suitability to meet the specified requirements, and he shall base his bid estimates solely on his own soil investigation. After the award of the contract no claim for a revision of bid prices depending on the sources of soil information will be entertained.

100.3 EXPLOSIVES

Where explosives are used the Contractor shall provide suitable buildings or warehouses in approved positions for the storage of explosives, which shall be stored in the manner and quantity approved by the Engineer or as per relative laws of government. Such storage places shall be accessible only to authorized personnel. They shall be properly marked, all doors or accesses thereto shall be constructed of materials as directed by the Engineer and provided with secure locks and all necessary means for preventing access by unauthorized persons. The Contractor shall be responsible for the prevention of any unauthorized issue or improper use of any explosives. The handling of explosives shall be entrusted only to experienced and responsible men, to the satisfaction of the Engineer, and in conformity with the statutory regulations.

All drilling and blasting shall be done in such a manner as to bring the excavation as close as possible to the required cross sections, and to disturb as little as possible the material to be left in place. Blasting by means of drill holes, tunnels, or any other method shall be performed at the entire risk and responsibility of the Contractor who shall have no claim to payment for extra work occasioned by breakage outside the approved cross-sections or dimensions.

The greatest care shall be taken by the Contractor during all blasting operations to ensure that no injury be done to persons or damage to property or to the finished work. Shots shall be properly loaded and capped, and only a moderate charge shall be used in each hole. A record of all explosives used, showing locations and amounts, shall be kept by the Contractor for checking by the Engineer.

Where directed by the Engineer, the Contractor shall provide heavy mesh blasting mat for protection of persons, property and the work. If necessary, blasting shall be restricted to time prescribed by the Engineer.

The Engineer may prohibit blasting and order the rock to be excavated by other means, if, in his opinion, it would be dangerous to persons or adjacent structures, or is being carried out in a reckless manner. If traffic on the road has to be interrupted, the Contractor shall obtain approval of his schedule for such interruption from the proper authorities and shall satisfy the Engineer that he has obtained it. No extra payment shall be admissible for such arrangements as described here above.

100.4 REMOVAL OF EXISTING OBSTRUCTIONS

The pay items under Items 101, 103, 105, 106, 107 and 108 shall include the cost of removal of all material regardless of its nature, encountered within the limits of the approved cross-section, including the removal and disposal, as required by the Engineer, of existing brick, stone, concrete or masonry, rock boulders or fragments, old pavements, culverts, bridges or parts thereof, retaining walls or any other material encountered during the excavation, unless a separate item exists for such features.

100.5 REMOVAL OR DIVERSION OF WATER

Except where provided for, no separate payment will be made for control of or removal of water during or after earthwork operations. The cost of sheeting, shoring, cofferdams, pumping and draining shall be included in the bid prices for earthwork. The Contractor shall provide necessary facilities for dewatering and for draining or diverting watercourses when necessary for the protection of the contract work or where required by the Engineer.

The Contractor shall provide such drainage outlet ditches or canals as may be necessary to effect proper drainage before rain is expected. Such drainage ditches or canals for protection of work during construction and their maintenance and clearing to make them continuously effective during the work shall not be paid separately, but shall be deemed to be included in other items of work.

The Contractor shall also provide, fix, maintain and operate such engines, pumps, hoses, chutes and other appliances as are necessary to keep the accumulated water at a level required for the safety of the structures as directed by the Engineer.

100.6 DITCHES

The Contractor shall construct side ditches, interception ditches, and inlet and outlet ditches as shown on the Drawings or where ordered by the Engineer, whether for temporary or permanent drainage. In order to keep water away from the embankment, subgrade, and/or pavement during construction, the Contractor shall at all times ensure adequate drainage by scheduling ditch and outlet so that the drainage is operative before work is stated on the embankment, subgrade or pavement. He shall clean and trim all such drainage ditches from time to time, so that there may be a free flow of water throughout the whole period of the Contract. Ditches shall first be trimmed according to approved cross-sections, and final trimming, including the repair of any damage that may have been done during the construction work, shall be carried out after the completion of the other construction work and shall be a condition for final approval and acceptance.

Unless otherwise specified no separate payment will be made for the excavation of side ditches, interception ditches, inlet and outlet ditches but such payment will be made under item 105 or 106 whichever applicable.

Where indicated on the drawings or when required by the Engineer, the Contractor shall take cross-sections of existing stream channels, and in collaboration with the Engineer, mark them with details of the excavation required for the relocation of the stream channel. Work shall not proceed without written approval of the marked cross-sections by the Engineer.

100.7 EXCAVATION FOR CULVERTS

Except where otherwise specified excavation and backfill for culvert and drainage pipes, except granular backfill to under drains, will not be paid for separately, but shall be considered as a subsidiary obligation of the Contractor covered under the contract price for the various classes of pipe culvert as provided in Item 501.

100.8 LANDSLIDES, BENCHES, FLATTENING OF SLOPES

The Engineer may order the removal of material resulting from landslides, the construction of benches in or above the cut slope or in the embankment slope or where in his opinion the slope shows signs of instability, the flattening of the slope. Payment of all such work shall be at contract prices in Item 106 or 108 as the case may be.

100.9 SURVEY AND LEVELING PRIOR TO COMMENCEMENT OF EARTHWORK

The Contractor shall be responsible for the setting out of the work in accordance with Clause 17 of the General Conditions of Contract. Notwithstanding that project drawings have been issued to the Contractor,

the Contractor shall also be responsible for taking joint cross-sections on the proposed alignment of the road, submitting three copies of the plotted cross-sections and longitudinal profile to the Engineer and obtaining the approval of the Engineer to such cross-section and longitudinal profile before any work in connection with Earthwork is commenced. These cross-sections and longitudinal profile shall be in the form and manner as instructed in writing by the Engineer.

100.10 **MEASUREMENT AND PAYMENT**

The quantities of the various classes of excavation or embankment to be measured for payment under the contract shall be limited to the lines and level as taken under clause 100.9 above. However if the levels so taken differ appreciably from design levels the mater shall be referred to the client.

Excavation and filling beyond the lines and level shown on the drawings, approved profiles and cross-sections will not be paid for. The Engineer will decide the angle of the slope of cuts and fills as the work proceeds on the basis of evaluation of the soil characteristics. The actual lines of the cuts and fills as made will be duly measured and recorded by the Contractor. The Engineer will check these records and will approve the measurements, if correct, as a basis of payment. Excess of excavation shall be backfilled, as directed by the Engineer, with subbase materials without extra payment to the Contractor; excess of fill may be either left in place or removed as required by the Engineer. The quantities of excavation, backfill and earthwork to be paid for in Items 103, 106, 107 and 108 respectively shall be the number of cubic meters of material measured by the average end-area method, except where the error may exceed plus or minus five percent as compared with the prismoidal formula in which case the Engineer will authorize the use of the more accurate method. However, the Contractor shall request such authority before he submits his quantities for approval. Quantities measured on the average end-area basis, once they have been submitted and approved, shall not be subject to review for the purpose of applying a more accurate method.

CLEARING AND GRUBBING

101.1 DESCRIPTION

This work shall consist of removal to the specified depth, grubbing and disposal of all surface objects, as and where directed in writing by the Engineer, stumps, roots, bushes and trees with less than 150 mm girth, vegetation, logs, rubbish and other objectionable material except such objects as are designated to remain or are to be removed in accordance with other section of specification.

101.2 CONSTRUCTION REQUIREMENTS

101.2.1 Clearing/Grubbing

In roadway cut areas, all surface objects or any object to the depth of 30 Cm. below subgrade level such as stumps, roots, vegetation, bushes, logs, rubbish shall be cleared and/or grubbed as directed by the Engineer. In roadway fill areas where clearing and grubbing is required, same shall be carried out to the depth of 30 Cm below natural surface level as described above.

Operation of clearing and grubbing shall in no way be deemed to effect any level or volume change of the area.

After clearing and grubbing, the compaction of the area will be restored to its original value without any extra payment. However Engineer may direct in writing to the Contractor for stripping (if so required) under item 103 or for compaction under item 104, Compaction of Natural Ground, if the original compaction is less than the required for respective zone. Payment of these items will be made separately under the relative items used for such purpose.

Before bottom layer of embankment is placed, contractor will grub up and remove without extra payment, any vegetation that may, in the meantime have grown on surface previously cleared and grubbed.

All trees having girth less than 150 mm measured at (600) mm above ground and falling within the construction limits shall be felled & removed by the contractor. The excavation and removal of trees, roots and stumps including backfilling and compacting of holes and restoring the natural ground to the original condition shall be responsibility of the contractor for which no extra payment shall be made to him. The trees, stumps & roots remains the property of the Employer, which shall be delivered at designated place as directed by the Engineer.

101.2.2 Protection and Restoration

The Contractor shall prevent damage to all pipes, conduits, wires, cables or structure above or below ground. No land monuments, property markers, or official datum points shall be damaged or removed until the Employer/Engineer has witnessed or otherwise referenced their locations

and approved their removal. The Contractor shall so control his operations as to prevent damage to shrubs, which are to be preserved. Protection may include fences and boards latched to shrubs, to prevent damage from machine operations. Any damage as a result of contractor's operation shall immediately be rectified by him at his own expense.

101.3 MEASUREMENT AND PAYMENT

101.3.1 Measurement

Clearing and grubbing will be measured for payment only on areas so designated in writing by the Engineer or shown on the drawings. The quantity to be paid for shall be the number of square meters satisfactorily cleared and grubbed. Any tree having girth of less than 150 mm (measured 600 mm above ground level) shall be measured to be under this item.

Engineer shall ensure that a minimum of 500 SM area is designated for clearing and grubbing in any stretch of roadway for the sake of ease to construction activities.

Clearing and grubbing carried out by the Contractor in roadway cut areas and borrow pits shall not be measured for payment.

101.3.2 Payment

The quantities determined as provided above will be paid for at the contract unit price for the pay item mentioned below and shown in the Bill of Quantities, which price and payment shall be full compensation for clearing and grubbing and restoration of area, to its original condition.

Pay Item No.	Description	Unit of Measurement
101	Clearing and Grubbing.	SM

REMOVAL OF TREES

102.1 DESCRIPTION

This work shall consist of the removal of trees and stumps alongwith their roots to a depth, to ensure complete removal of roots and stumps and their disposal as provided in Special Provision or as directed in writing by the Engineer.

102.2 CONSTRUCTION REQUIREMENTS

Such individual trees as the Engineer may designate and mark in white paint shall be left standing uninjured. All other trees to be removed shall be counted and an inventory prepared showing girth of the tree stem.

When necessary to prevent injury to other trees or structures or to minimise danger to traffic, trees shall be cut in sections from top downwards.

Hole or loose earth resulting from the removal of trees shall be filled and recompacted to a degree of compaction of adjoining area. Any extra material required for such purpose shall not be measured for payment.

102.3 GENERAL REQUIREMENTS

Contractor shall prevent damage to all under-ground utilities, such as pipes cables or conduits etc. For this purpose if so required, removal of trees shall be carried out manually. Any under-ground or over-ground property damaged by the contractor shall be immediately repaired by the contractor at his own expense.

102.4 MEASUREMENT AND PAYMENT

102.4.1 Measurement

Engineer and Contractor shall jointly measure the girth and number of trees to be removed under this item. Any tree having a girth of less than 150 mm measured six hundred (600) mm above ground level shall not be measured under this item, as the same shall be removed under item "Clearing and Grubbing".

102.4.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price for the pay item mentioned below and shown in the Bill of Quantities which price shall be deemed to include all cost of labour equipment and incidental related to the item.

Pay Item No.	Description	Unit of Measurement
102 a	Removal of trees, 150-300 mm girth	Each
102 b	Removal of trees, 301-600 mm girth	Each
102 c	Removal of trees, 601 mm or over girth	Each

103.1 DESCRIPTION

This work shall consist of removing unsuitable topsoil, transporting and depositing in stockpiles or spreading where indicated on the Drawings or as directed by the Engineer. Engineer shall give instruction in writing, stating area and depth to be stripped.

103.2 CONSTRUCTION REQUIREMENTS

The areas from which stripping of topsoil is required shall be as indicated on the Drawings or as directed by the Engineer. The Contractor shall remove topsoil from these areas to depth as directed by Engineer. Stripping of topsoil in any case shall be not less than 10 cm. in depth. The removed topsoil shall be transported, deposited in stock piles at locations designated by the Engineer and/or spread where indicated on the drawings or as directed by the Engineer. Engineer shall, however identify the soil as unsuitable through laboratory tests

The top soil shall be placed separately from other excavated materials and be completely removed to the required depth from the area prior to the beginning of regular excavation or embankment work in that area. No payment will be made for topsoil removed from places other than that directed by the Engineer. Engineer shall, however identify the soil as unsuitable through laboratory tests, before such a decision.

103.3 MEASUREMENT AND PAYMENT

103.3.1 Measurement

Measurement shall be made by multiplying the length, breadth and depth of layer approved by the Engineer in cubic meter of material removed and disposed as directed by the Engineer. However space thus created shall be filled by the material as directed by the Engineer and paid separately under relative item.

103.3.2 Payment

The payment under this item shall be made for at the contract unit price per cubic meter of stripping measured as above, for removal of material to a depth approved by the Engineer including its disposal at designated place and in the manner as directed by the Engineer.

Pay Item No.	Description	Unit of Measurement
103	Stripping.	CM

ITEM 104 COMPACTION OF NATURAL GROUND.

104.1 DESCRIPTION.

The natural ground or surface ready for construction purposes after clearing and grubbing or stripping, (if required) will be considered as (natural) Ground for the purpose of this item. The compaction of natural ground shall be carried out through a written order by the Engineer.

104.2 CONSTRUCTION REQUIREMENTS.

Up to a depth of twenty (20) cm below the natural ground, all sods and vegetable matters shall be removed and clear surface shall be broken up by ploughing and scarifying to compact to the degree as defined below:-

For height of Embankment below sub grade level.	Percent of Maximum Dry Density as determined by AASHTO T-180.*
0 to 30 cm	95
30 to 75 cm	93
Over 75 cm	90
Below the foundation of structures	95

104.2.1 Compaction of original ground surface in areas of high water levels and salinity.

Compaction of the natural ground surface in such areas will be difficult if not impossible. See Items 108, etc. under Formation of Embankment for construction requirements under these conditions, where compaction of Natural Ground shall not be carried out.

104.3 MEASUREMENT AND PAYMENT.

104.3.1 Measurement.

The measurement shall be made by multiplying the length and breadth of the area approved in writing by the Engineer to be paid under this item. The measurement of the item shall be in Square meter.

Any subsidence of levels of Natural Ground due to compaction under this item shall not be measured for payment, the contractor is expected to take care of such factors while bidding.

104.3.2 Payment.

The payment under this item shall be made for at the contract unit price for Square meter of compaction of (natural) ground measured as above and shall be deemed to include cost of scarification, watering, mixing, leveling, rolling, labour, equipment, tools, and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
104	Compaction of Natural Ground	SM

ITEM 105 ROADWAY AND BORROW EXCAVATION FOR EMBANKMENT

105.1 DESCRIPTION

The work shall consist of excavating the roadway and borrowpits, removal and satisfactory disposal of all materials taken from within the limits of the work, also such excavation as is necessary for inlet and outlet ditches of structures and shall include all excavation, shaping and sloping for the construction, preparation of all embankment, subgrade, shoulders, intersections and approaches as directed and in conformity to the alignment, grade, level and cross-sections shown on the plans or established by the Engineer.

105.2 CLASSIFICATION OF EXCAVATION

105.2.1 Road Way Excavation

Roadway Excavation shall comprise all excavation that is not classified as structural excavation carried out within the limits of roadway including permanent drainage ditches and side slopes in cut.

Roadway Excavation shall further, be classified as "Common Excavation", or "Rock Excavation", (common excavation shall include all the materials of whatever nature encountered but not including rock excavation).

a) Common Excavation

Common excavation shall consist of the removal and satisfactory disposal of all eolian, alluvial and residual materials, inplace unaltered and unweathered strata, which are not firm or rigid enough to possess all the characteristics of "Rock Excavation". Boulders of less than one quarter (1/4) cubic meter volume shall also be classified as "Common Excavation". Eolian and alluvial materials consist of gravel, shale, volcanic ash, loess, dunes and, loams, sands and clays or any combination of these materials, and termed as Common Excavation.

b) Rock Excavation

This includes firm and rigid igneous, metamorphic and sedimentary rocks. Boulders larger than quarter (1/4) cubic meter in volume will also be considered as "Rock Excavation", provided these are firm and stable lying in continuous bed and constitute more than 50% by volume as compared to other type of materials in the total mass.

The classification of Hard, Medium or Soft Rock shall be same as described under item 106.2 of General Specifications.

105.2.2 **Borrow Excavation**

Borrow Excavation shall comprise all excavation taken from borrow pits. Material from borrow pits shall normally be used for the construction of embankment or for the backfill when there is no material available from roadway excavation or structural excavation. Permission to use material from borrowpit shall first be obtained in writing from the Engineer. Nevertheless the total quantity of material from roadway excavation and structural excavation after deduction of the material declared unsuitable by the Engineer, shall be considered available for use in the work and any material used from borrow pits for formation of embankment shall not be measured for payment.

In making his bid, the Contractor shall inspect the site and prepare his estimate of the haulage cost on the basis of his own survey of the possible nature and locations of the borrow pits. Their distance from the work sites shall not be grounds for extra payment or revision of the contract price.

The consent of the landowner or tenant for excavating the borrow material and hauling along private access roads shall be secured by the Contractor who shall, if required, pay for such concession. Borrow pits shall be left in a condition acceptable to the landowner and/or tenant and the Engineer.

105.2.3 **Structural Excavation**

The description method of measurement and payment of this section shall conform to as specified in item 107.

105.3 **CONSTRUCTION REQUIREMENTS**

All material removed from excavation shall be used in the formation of embankment, subgrade, shoulders, and at such other places as directed, unless it is declared unsuitable and ordered to waste by the Engineer. No excavated material shall be wasted without written permission from the Engineer, and when such material is to be wasted, it shall be so placed that it will present a neat appearance and not offer any danger to abutting property.

The material shall be declared unsuitable if the soaked CBR (96 hours) is less than five (5) percent or if falls under A-6 or A-7 of AASHTO soil classification.

During construction of the roadway, the road bed shall be maintained in such a condition that it will be well drained at all times.

All slopes, except in solid rock or other material shall be trimmed precisely as per cross-sections, and care must be exercised that no material shall be loosened beyond the required slopes. In blasting rock slopes, a reasonably uniform face shall be left, regardless of whether or not the excavation is carried beyond the *specified side slope*. All breakage and slides shall be removed by the contractor and disposed of as directed by the Engineer.

Rock, shale and other unsuitable road bed material encountered in cuts shall be excavated to required width and depth indicated on the plans or as otherwise directed. Any overbreakage below the depth shown on the plans will not be paid for. Backfill of the overcut shall be of approved earth material and shall have the same density requirements as specified on the plans and shall be at the expense of contractor.

Borrowpits shall be located so that the nearest edge of the pit is at least thirty (30) meters from the roadway toe of slope unless otherwise directed by the Engineer.

Permission to use any borrow material, including its suitability, shall be obtained in writing from the Engineer before execution of work. It is responsibility of the contractor to submit a request for test at least fifteen (15) working days prior to the day the contractor intends to begin taking material from the borrow area.

In no case shall borrow material be obtained from downstream of any hydraulic structure. However the borrowpit may be established at five hundred (500) meters upstream of the hydraulic structure. The side slopes of the pits or channels shall be constructed as shown on the plans or directed by the Engineer. In no case the side slopes of borrow pit be steeper than a slope; 1:5 (V:H).

Upon abandonment of borrow pit or quarry area, the contractor shall, at his own expense, clean and trim the borrow pit or quarry area, the right of way, and adjoining properties which were occupied during execution of work, all to the satisfaction of the Engineer.

All drilling and blasting shall be done in such a manner as will most nearly complete the excavation to the required grade line, and produce the least disturbance of the material to be left in place. Blasting by means of drill holes or any other methods shall be performed at the entire risk and responsibility of the contractor. Care shall be taken to ensure that no injury be done to persons or properties or to the finished work. Blasting shall be restricted to the hours prescribed by the local authorities or the Engineer.

Where between two successive cross-sections of the road, the properties of rock boulders, in sizes larger than a one quarter (1/4) of a cubic meter, to earth is more than 50%, the excavation will be considered wholly as rock.

Rock material above ground level such as stones, boulders, piles of stone, and dry stones walling whose individual sizes are greater than one quarter of a cubic meter shall be removed and disposed of if directed in writing by the Engineer and shall be paid under relevant item of work in the Bill of Quantities.

105.4 MEASUREMENT AND PAYMENT

105.4.1 Measurement

When the Bill of Quantities specifies for "Common Excavation", "Rock Excavation" and "Borrow Excavation" the quantities of the different classes of excavation shall be computed as follows:

a) Common Excavation

The unit of measurement for common excavation shall be in cubic meter and be computed by average end area method based on cross-sections duly approved by the Engineer prior to commencement and completion of required excavation.

The excavated material approved for fill under any item of the Bill of Quantities shall be used in the manner as described under the relevant item of work, irrespective of haulage distance.

b) Rock Excavation

Authorized "Rock Excavation" to be measured in cubic meters shall consist of area that is necessary to provide the design section and grade or as directed by the Engineer. Any over breakage beyond the lines shown on the plans and outside of the tolerances set for subgrade in cuts shall not be paid for. The Engineer shall define the beginning and ending points of areas classified as "Rock Excavation". Any area over excavated in the subgrade shall be reinstated at the cost of contractor as directed by the Engineer.

The pay quantity for "Rock Excavation" shall be computed by means of average end area method from approved cross-sections based on original ground elevations after the authorized removal of unsuitable or overburden materials, if required.

For disposal of excavated rock material, same procedure shall be followed as described above for the "Common Excavation" specified in sub item No.105.4.1 (a).

c) Borrow Excavation

No measurement shall be made for any Borrow Excavation, however this material if used in any of the Bill items, shall be measured and paid as provided under the relative items of work.

105.4.2 Payment

No payment for Roadway or Borrow Excavation shall be made under this item as the same is deemed to be included under relative item of Formation of Embankment.

ITEM 106

EXCAVATION OF UNSUITABLE OR SURPLUS MATERIAL

106.1 DESCRIPTION

The work shall consist of excavation and disposal of unsuitable or surplus material arising from roadway excavation, which is declared in writing by the Engineer to be unsuitable for use or surplus to the requirements of the project. When excavation of unsuitable material requires special attention for a known condition on a specific project, construction requirements and payment shall be covered under relevant Provisions.

106.2 CONSTRUCTION REQUIREMENTS

All suitable material excavated within the limits and scope of the project shall be used in the most effective manner for the formation of the embankment, for widening of roadway, for backfill, or for other work included in the contract.

Any material surplus to these requirement or any material declared in writing by the Engineer to be unsuitable shall be disposed of and leveled in thin layers by the Contractor outside the right of way within 7 Km of excavation. The Engineer shall decide regarding the unsuitability of the material by conducting appropriate laboratory tests.

When unsuitable materials are ordered to be removed and replaced, the soil left in place shall be compacted to a depth of twenty (20) cm to the density prescribed under Item 108.3.1. Payment for such compaction shall be included in the contract prices for the excavation materials.

If the unsuitable material, which is to be removed, is below standing water level and the replacement material is gravel or a similar self-draining material of at least thirty (30) cm in depth, the compaction may be dispensed with if approved by the Engineer.

Rock excavation shall be classified as under:

a) Hard Rock

Any rock which can not be removed with Ripper of a 200 H.P. Bulldozer and constitutes a firm and continuous bed of rock only.

b) Medium Rock

Any rock which can not be removed with the blade of 200 H.P. Buldozer but can be removed by the ripper, will be termed as Medium Rock, irrespective of the fact that it is removed by blasting.

c) Soft Rock

Any rock which can be removed with the blade of a 200 H.P. Bulldozer. This item will be termed as Soft Rock, irrespective of the fact that it is removed by blasting.

106.3 MEASUREMENT AND PAYMENT

106.3.1 Measurement

When the contractor is directed to excavate unsuitable material below the surface of original ground in fill areas, the depth to which these unsuitable materials are to be removed will be determined by the Engineer. The contractor shall schedule his work in a such a way that authorized cross sections can be taken before and after the material has been removed. Only material which is surplus to the requirements of the project or is declared in writing by the Engineer to be unsuitable will qualify for payments under pay Item No. 106 a, 106 b, 106 c, and 106 d as the case may be.

The cost of excavation of material which is used anywhere in the project shall be deemed to be included in the pay Item relating to the part of the work where the material is used.

The under mentioned Pay Item Nos. 106 a, 106 b, 106 c, and 106 d shall include the cost of obtaining the consent of the owner or tenant of the land where the disposal of surplus or unsuitable material is made.

Unsuitable or surplus material shall be measured in its original position and its volume shall be calculated in cubic meters using end area method.

106.3.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay Items listed below and shown in the Bill of Quantities which prices and payment shall constitute full compensation for all costs involved in the proper completion of the work prescribed in this item.

Pay Item No.	Description	Unit of Measurement
106a	Excavate Unsuitable Common Material	CM
106b	Excavate Unsuitable Rock Material.	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
106c	Excavate Surplus Common Material	CM
106d	Excavate Surplus Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	

107.1 DESCRIPTION

Structural excavation shall include the removal of all material of whatever nature, necessary for the construction of foundations of bridges, culverts, retaining walls, headwalls, wing walls, catch basins, manholes, inlets and other structures not otherwise provided for in these specifications and in accordance with the plans or as directed by the Engineer. It shall include the furnishing of all necessary equipment and construction of all cribs, cofferdams, caissons, dewatering, sheeting, shoring etc., which may be necessary for the execution of the work. It shall also include the subsequent removal of cofferdams and cribs and the placement of all necessary backfill as hereinafter specified. It shall also include the disposing of excavated material, which is not required for backfill, in a manner and in locations so as not to affect the carrying capacity of any channel and not to be unsightly.

107.2 MATERIAL REQUIREMENT FOR BACKFILL

107.2.1 Backfill around structure

Backfill around structure shall be made with the following material.

a. Granular backfill of selected material as specified here under
b. Common backfill shall be carried out from excavated material or any other borrow material approved by the Engineer.

107.2.2 Granular backfill

Granular backfill material shall meet the following requirements.

a) **Grading Requirement**

mm	Inch.	A	B
25	1"	100	100
19	3/4"	60-100	75-100
4.75	No. 4	50-85	55-100
2.0	No. 10	40-70	40-100
0.425	NO. 40	25-45	20-50
0.075	No. 200	0-15	5-15

b) Material satisfying the requirements of coarse sand falling under soil classification A-3 (AASHTO). In case, coarse sand is utilised for granular fill it shall be ensured that the same is confined properly with approved material.

c) The material shall have a Plasticity Index of not more than size (6) as determined by AASHTO T-89 and T-90.

107.2.3 **Common backfill**

Use of excavated material as backfill may be allowed under this item. Use of borrow material for common backfill shall be allowed subject to approval of borrow material by the Engineer.

107.2.4 **Rock backfill**

Rock material of small size shall be permitted in the backfilling of structures or walls subject to the approval of methodology by the Engineer.

107.3 CONSTRUCTION REQUIREMENTS

107.3.1 Structural excavation

a) General

All substructures, where practicable, shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced, or protected by cofferdams in accordance with approved methods. When footings can be placed in the dry without the use of cribs or cofferdams, backforms may be omitted with the approval of the Engineer, and the entire excavation filled with lean concrete to the required elevation of the top of the footing. The additional concrete shall be at the expense of the Contractor.

In case the contractor has excavated additional volumes than specified thereunder, the contractor shall at his own expense backfill the volume with approved material as directed by Engineer.

The classification of Hard, Medium or Soft Rock shall be same as described under item 106.2 of General Specifications.

b) Preservation of channel

Unless otherwise specified, no excavation shall be made outside of caissons, cribs, cofferdams, piling, or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs or cofferdams are in place, the Contractor shall, without extra charge, after the foundation base is in place, backfill all such excavation to the original ground surface or river bed with material approved by the Engineer. Material deposited within the stream area from foundation or other excavation or from filling of cofferdams shall be removed and the stream bed freed from obstruction thereby.

c) Depth of Footings

The elevation of the bottoms of footings, as shown on the drawings, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

d) Preparation of Foundations of Footings

i) All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either leveled, stepped, or roughened, as may be directed by the Engineer.

ii) When masonry is to rest on an excavated surface other than rock special, care shall be taken not to disturb the bottom of the excavation, and the final leveling of the grade shall not be made until just before the masonry is to be placed.

e) Cofferdams and Cribs

i) For substructure work, the contractor shall submit, upon request, drawings showing his proposed method of cofferdams construction and other details left open to his choice or not fully shown on the Engineer's drawings. The Contractor shall not start work until the Engineer has approved such drawings.

ii) Cofferdams and cribs for foundation construction shall be carried to adequate depths and heights, be safely designed and constructed, and be made as water tight as is necessary for the proper performance of the work which must be done inside them. In general, the interior dimensions of cofferdams and cribs shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside the forms. Cofferdams or cribs, which are tilted or moved laterally during the process of sinking, shall be righted, reset, or enlarged so as to provide the necessary clearance and this shall be solely at the expense of the Contractor.

iii) When conditions are encountered which, in the opinion of the Engineer, render it impracticable to dewater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation water shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal, and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

iv) Cofferdams or cribs shall be constructed so as to protect green concrete against damage from a sudden rising of the stream or river and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry without written permission from the Engineer.

v) Unless otherwise provided, cofferdams of cribs with all sheeting and bracing shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished masonry.

f) Pumping

i) Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping of water will be permitted during the placing of concrete or for a period of at least twenty four (24) hours thereafter, unless it is done from a suitable sump pit separated from the concrete work by a watertight wall or other effective means.

ii) Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to with stand the hydrostatic pressure.

g) Inspection

After each excavation is completed the Contractor shall notify the Engineer, and no concrete or masonry shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

In case if an existing structure is to be replaced with a new structure the quantities for dismantling the structure shall be paid under item 510 (Dismantling of structures) and additional excavation required shall be carried out under this item.

h) Classification of Excavation

Classification of excavation shall be made as described under items 106.2 of this Specification.

107.3.2 **Excavation in Embankments**

Unless otherwise specified, the Contractor may choose with the approval of the Engineer to excavate for structures, culverts, and pipe culverts after the embankment has been placed. Any space remaining after the placing of such structures or culverts shall be filled with material approved by the Engineer and compacted as follows :

Layers of not more than 20 cm in loose thickness shall be placed and compacted in succession, with mechanical tampers, plate compactors or hand guided rollers operated transversely to the roadway, to the densities specified in the item 108.3.1. Moisture content shall be adjusted as directed by the Engineer. Proper benching shall be made to ensure bonding of existing and new material without any extra payment.

The excavation in embankment and the placing of backfill for the purposes described above shall not constitute any claim for payment. also if sand or granular backfill is used by the contractor for his convenience, no extra payment will be made.

107.3.3 **Backfill**

a) Granular backfill where-ever directed shall be placed in the position and to the required depth, shown on the drawings or where and as required in writing by the Engineer and it shall be well compacted in layers not exceeding twenty (20) cm in thickness to 100 percent of Max. dry density as per AASHTO T-180 (D). In case of water logged areas the thickness of the layer shall not exceed fifty (50) centimeters or as directed by the Engineer. Volume of granular fill around structures shall be calculated within the vertical limits of approved excavation for such a structure, where as the horizontal limits shall be those as specified on drawings.

b) Common backfill shall consist of earth free from large lumps, wood and other organic materials and of a quality acceptable to the Engineer. It shall be placed in the position and to the required depths shown on the Drawings and/or as required in writing by the Engineer and it shall be well compacted in layers not to exceed twenty (20) cms in depth to the density, 95 percent of maximum dry density, as per AASHTO T-180 (D).

c) The rock backfill material whose individual sizes are not more than 30 cm shall be placed in the position to the required depth as specified and the voids shall be filled in layer of fine material approved by the Engineer. The compacting efforts shall be made so as to achieve the desired compaction approved visually by the Engineer. The depth of the layer in any case shall not exceed sixty (60) centimeters. However in water logged areas, the thickness may be increased as directed by the Engineer. Rock backfill will not be placed within two meters from concrete face of any structure.

d) All spaces excavated and not occupied by abutments, piers or other permanent work shall be refilled with earth or granular fill as approved by the Engineer up to the surface of the surrounding ground, with a sufficient allowance for settlement. All such backfill shall be thoroughly compacted and, in general, its top surface shall be neatly graded.

e) The fill behind abutments and wing walls of all bridge structures shall be deposited in well-compacted, horizontal layers not to exceed twenty (20) cm. in thickness. The common backfill in front of such units shall be placed first to prevent the possibility of forward movement.

Special precautions shall be taken to prevent any wedging action against the masonry, and the slope bounding the excavation for abutments and wingwalls shall be destroyed by stepping or roughening to prevent wedge action. Jetting of the fill behind abutments and wingwalls will not be permitted.

f) Fill placed around culverts and piers shall be deposited on both sides to approximately the same elevation at the same time. Where the Contractor does not have proper equipments to ensure compaction in restricted areas, Engineer may allow backfill with sand saturation method, at no extra cost to the Client.

g) Adequate provision shall be made for the through drainage of all backfill. French drains shall be placed as weep holes.

h) No backfill shall be placed against concrete or masonry structure before fourteen (14) days of placement and backfilling shall be carried out on both sides of the structure simultaneously.

107.4 MEASUREMENT AND PAYMENT

107.4.1 Measurement

a) Structural Excavation

The quantities of structural excavation to be paid for shall be the number of cubic meters of material measured in its original position computed by the average end-area method, and excavated to the satisfaction of the Engineer.

Structural Excavation will be classified for measurement and payment as "Structural Excavation in Common Material", "Structural Excavation in Common Material Below Water Level", "Structural Excavation in Rock Material" and according to whether the excavation is in earth or rock and according to whether the excavation is above or below the water level which is the constant level to which the water naturally rises in a foundation pit.

The volume of earth or rock to be measured for structural excavation shall consist of a prismoid bounded by the following planes:-

1) The vertical limits for computing pay quantities will be vertical planes 50 centimeters outside of the neat lines of footings or foundations as shown on the Drawings or as directed by the Engineer.

2) The upper limit for payment of structural excavation shall be the ground surface as it existed prior to the start of construction operations, except where structural excavation is performed within roadway excavation or ditch excavation areas, the upper limit shall be the planes of the bottom and side slopes of said excavated areas.

3) The lower limits for computing pay quantities of structural excavation or structure backfill shall be a plane at the bottom of the completed footings, foundations, structures or lean concrete.

Measurement for structural excavation shall not include material removed below the footing grade and beyond specific limits to compensate for anticipated swell or as a result of effective swell during pile driving, or additional material resulting from slides, slips, cave-ins, silting or fillings, whether due to the action of the elements or to carelessness of the Contractor. The depths of the footings shown on the drawings are approximate only and any variation found to be necessary during construction shall be paid for at the contract unit price.

b) Granular Backfill

The quantities of Granular Backfill to be paid for shall be the number of cubic meters of material laid and compacted in place within the line of structure and limits defined in Item 107.4.1 (a) above, computed and accepted by the Engineer.

c) Common Backfill

The quantities of Common Backfill to be paid for shall be the number of cubic meters of material laid and compacted, placed within the lines of structure and limits defined in Item 107.4.1(a) above and accepted by the Engineer.

107.4.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay item listed below that is shown in the Bill of Quantities, which price and payment shall be full compensation for all the costs involved in the proper completion of the work prescribed in this item.

Pay Item No.	Description	Unit of Measurement
107a	Structural Excavation in Common Material	CM
107b	Structural Excavation in Common Material Below Water Level	CM
107c	Structural Excavation in Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
107d	Granular Backfill type--	CM
107e	Common Backfill	CM

108.1 DESCRIPTION

This work shall consist of formation of embankment, including preparation of area for placing and compaction of embankment material in layers and in holes, pits and other depressions within the roadway area in accordance with the specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the plans or established by the Engineer.

108.2 MATERIAL REQUIREMENTS

Material for embankment shall consist of suitable material excavated from borrow, roadway excavation or structural excavation and shall include all lead and lift. Borrow material will be used only when material obtained from roadway or structural excavation is not suitable or is deficient for embankment formation and shall include all lead and lift.

The material under this item shall conform to the following specification.

a) Contractor shall use AASHTO Class A-1, A-2, A-3, A-4 or A-5 soil as specified in AASHTO M-145 or other material approved by the Engineer.

b) CBR of the material shall not be less than five (5) percent, determined in accordance with AASHTO T-193. CBR value shall be obtained at a density corresponding to the degree of compaction required for the corresponding layer.

c) Swell value of the material for embankment formation shall not exceed five tenth (0.5) percent. However, while establishing the swell value, surcharge weights representing the overburden will be used. In case sandy material is used for embankment formation, it shall be properly confined at no extra payment with a material and to the extent as approved by the Engineer and sandy material shall not be used on slopes of embankment.

d) In areas subject to flood and prolonged inundation of the embankment, such as at bridge sites, the material used in embankment, unless rock, shall be AASHTO Class A1 (a), A1 (b) and A-2-4, soils. Other soils may be used only with the written consent of Engineer.

108.3 CONSTRUCTION REQUIREMENTS

108.3.1 Formation of Embankment with Borrow Common Material

Material for embankment, obtained and approved as provided above, shall be placed in horizontal layers of uniform thickness and in conformity with

the lines, grades, sections and dimensions shown on the Drawings or as required by the Engineer. The layers of loose material other than rock shall be not more than 20 cm. thick, unless otherwise allowed by the Engineer after a trial section is prepared and approved.

The material placed in layers and that scarified to the designated depth for formation of embankment shall be compacted to the density specified below:

Depth in centimeters below subgrade Level	Percent of Maximum Dry Density, as determined by AASHTO T-180. *
0 to 30	95
30 to 75	93
Over 75	90

* Method 'B' or 'D' whichever is applicable, or corresponding Relative Density in case of sand fill.

In-place density determinations of the compacted layers shall be made in accordance with AASHTO T-191 or other approved methods. For all soils, with the exception of rock fill materials, containing more than 10% oversize particles (retained on 3/4 inch/ 19 mm sieve), the in-place density thus obtained shall be adjusted to account for such oversize particles or as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer.

Material for embankment at locations inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 15 centimeters thick and compacted to the densities specified above by the use of mechanical tempers, or other appropriate equipment.

The compaction of the embankment shall be carried out at the designated moisture content consistent with the available compacting equipment.

Embankment material that does not contain sufficient moisture to obtain the required compaction shall be given additional moisture by means of approved sprinklers and mixing. Material containing more than the optimum moisture may not, without written approval of the Engineer, be incorporated in the embankment until it has been sufficiently dried out. The drying of wet material may be expedited by scarification, disking or other approved methods.

When materials of widely divergent characteristics, such as clay and chalk or sand, drawn from different sources, are to be used in the embankment they shall be deposited in alternate layers of the same material over the full width of the embankment to depths approved by the Engineer. Rock, clay or other material shall be broken up, and no accumulation of lumps or boulders in the embankment will be permitted. No surplus material shall be permitted to be left at the toe of embankment or at the top of cut sections.

Side slopes shall be neatly trimmed to the lines and slopes shown on the drawings or as directed by the Engineer, and the finished work shall be left in a neat and acceptable condition.

108.3.2 **Formation of Embankment With Rock Material**

Embankment formed of material consisting predominantly of rock fragment of such size that the material cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces, such material may be placed in layers not exceeding in thickness than the approximate average size of the rocks except that no layer shall exceed eighty (80) centimeters of loose measurement and compacted by a vibratory roller with the minimum mass as shown in the following table.

Mass per metre width of vibrating roll (Kg/M)	Depth of fill layer (mm)	Number of passes of the roller on each layer
2300 – 2900	400	5
2900 – 3600	500	5
2600 – 4300	600	5
4300 – 500	700	5
>5000	800	5

The material shall be carefully placed in layers, so that all larger stones will be well distributed and voids completely filled with smaller stones, clean small spells, shale, earth, sand, gravel, to form a solid mass. After placing rock material, surface shall be covered with a layer of fine material having thickness less than twenty (20) centimeters. Such fine material shall be reserved from roadway excavation by the Contractor. Should such material be available but not reserved, Contractor will supply and place borrow material for forming smooth grade without extra payment.

Each layer shall be bladed or leveled with motor grader, bulldozer or similar equipment capable of shifting and forming the layer into a neat and orderly condition. No rock larger than eight (8) centimeters in any dimension shall be placed in the top fifteen (15) centimeters of embankment unless otherwise allowed by the Engineer.

Material for each layer should be consolidated with heavy weight vibratory roller until settlement as checked between two consecutive passes of roller is less that one (1) percent of the layer thickness. In evaluation of settlement, survey points should be established and rolling continued until difference of levels as checked after two consecutive passes is less than one (1) percent of the total layer thickness. More over initial rolling of overlaid fine material shall be done without watering to ensure their intrusion in voids of rock layer beneath. Watering shall be done when voids are properly filled.

Embankments, which are formed of material that contain rock but also contain sufficient compactable material other than rock or other hard material to make rolling feasible, shall be placed and compacted in the manner prescribed above and to the point when settlement is within above mentioned requirement. Compaction test will be made whenever the Engineer determines they are feasible and necessary. Each layer must be approved by the Engineer before the next layer is placed.

When rock to be incorporated in fill is composed largely of weak or friable material, the rock shall be reduced to a maximum size not exceeding fifty (50) percent of the thickness of the layer being placed.

108.3.3 **Formation of Embankment on Steep Slopes**

Where embankments are to be constructed on steep slope, hill sides or where new fill is to be placed and compacted against existing pavement or where embankment is to be built along one half the width at a time, the original slope of the hill side, of existing pavement or adjacent to half width of embankment shall be cut in steps of twenty (20) centimeters depth. Benching shall be of sufficient width to permit operation of equipment possible during placing and compaction of material.

Cut material shall be incorporated with the new embankment material and compacted in horizontal layers. No extra payment will be allowed for such an operation.

108.3.4 **Formation of Embankment on Existing Roads**

Before fill is placed and compacted on an existing roadway, the existing embankment and/or pavement may be leveled by cutting, rooting or scarifying by approved mechanical means to a level to be determined by the Engineer. The earth, old asphalt or other material arising as a result of this operation will be declared either suitable or unsuitable, for use in the embankment or other items, by the Engineer. If the material is declared suitable it will be measured under relative item and if it is declared unsuitable, it will be measured under item 106a.

108.3.5 **Formation of Embankment in Water Logged Areas**

Where embankments are to be placed in water logged areas and which are inaccessible to heavy construction equipment, a special working platform shall be first established, consisting of a blanket of fill material placed on top of the soft layer. The material of the working table shall consist of normal or processed granular fill, obtained from borrow excavation. This material shall conform to the following specifications:

Sieve Description	Percentage of Weight Passing Mesh Sieve, AASHTO T-27
3 inch (75 mm)	100

The remaining grading shall be such as to avoid intrusion into the working platform material of subgrade or natural ground surface material. For this condition to be met it will be required that the ratio.

$$\frac{D_{15}\text{(Working Platform Material)}}{D_{85}\text{ (Natural Ground Material)}} \text{ is less than 5.}$$

D_{85} and D_{15} mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

Construction of this working table shall proceed from one edge of the soft area by using the fill as a ramp for further material transport.

The thickness of the working table as prescribed above shall be approximately 0.5 meter unless directed otherwise by the Engineer, and the width shall be that of the embankment. The placement and compaction of the working table shall be carried out by use of light equipment, as directed by the Engineer.

No density requirements are specified for the working platform, however, subsequent layers above it shall be compacted to the densities specified in Item 108.3.1.

108.3.6 General Requirements

To avoid interference with the construction of bridge abutments and wing walls, the Contractor shall at points determined by the Engineer, suspend work on embankments and/or in cuts forming the approaches to any such structure until such time as the construction of the later is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included in the contract unit prices for embankment. In carrying embankments up to or over bridges, culverts or pipe drainage, care shall be taken by the Contractor to have the embankments brought to equally on both sides and over the top of any such structure. Contractor shall make special arrangements to ensure proper compaction in restricted spaces and around structures. No compensation shall be made to the Contractor for working in narrow or otherwise restricted areas.

When as a result of settlement, an embankment requires the addition of material up to 30 cm in thickness to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified before the additional material is being placed, without extra payment to Contractor for the scarification.

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that in the opinion of the Engineer have been damaged or displaced due to carelessness or neglect on the part of the Contractor. Embankment material which may be lost or displaced as a result of natural causes such as storms, cloud-burst or as a result of unavoidable movement or settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. No additional compensation will be allowed for the replacement.

During construction, the roadway shall be kept in shape and drained out at all times. When unsuitable material has been placed in the embankment by the Contractor, he shall remove it without extra payment.

108.4 MEASUREMENT AND PAYMENT

108.4.1 Measurement

The quantities to be paid for shall be the number of cubic meters calculated on theoretical designed lines and grades and the ground levels as established under clause 100.9, compacted in place, accepted by the Engineer formed with material resulting from:

i) **Formation of Embankment from Borrow Excavation**

Measurement shall be made as under:-

Formation from Borrow = Total Embankment Quantity (minus) Roadway excavation Quantity (minus) structural excavation Quantity.

ii) **Formation from structural Excavation**

This quantity shall be the same as calculated for structural excavation irrespective of its haulage distance except that declared unsuitable by the Engineer.

iii) **Formation from Roadway Excavation.**

This quantity shall be the same as calculated for Roadway Excavation. The contractor will be supposed to use material from Roadway Excavation irrespective of haulage distance. However if contractor, for his own convenience, uses the material from borrow, the payment will still be made under this item 108 (a) & 108 (b).

In the measurement of "Formation of Embankment on steep slopes" no allowance will be made for the benching or volume of material cut out from the hill side or from the first half width fill to accommodate the compacting equipment but will be calculated only on the net volume of fill placed against the original hill sides, the old embankment or the first half width fill.

108.4.2 **Payment.**

a) **Formation from Borrow Excavation .**

The quantity to be paid for shall be the number of cubic meters placed in embankment, measured as provided above for material from borrow excavation and such a payment will be deemed to include cost of excavation, payment of royalty, levies and taxes of Local, Provincial and Federal Government, cost of hauling including all lead and lift, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

b) **Formation from Structural Excavation.**

The quantity to be paid for shall be the number of cubic meters placed in embankment and measured as provided above for material from structural excavation and such payment will be deemed to include cost of excavation, hauling, dumping, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

c) Formation from Roadway Excavation

The quantity to be paid for shall be the number of cubic meters placed in embankment and measured as provided above for material form roadway excavation and such payment will be deemed to include cost of excavation, hauling, dumping, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
108a	Formation of Embankment form Roadway Excavation in Common Material	CM
108b	Formation of Embankment from Roadway Excavation in Rock Material.	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
108c	Formation of Embankment from Borrow Excavation in Common Material.	CM
108d	Formation of Embankment from Structural Excavation in Common Material.	CM
108e	Formation of Embankment from Structural Excavation in Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM

109.1 DESCRIPTION

The subgrade preparation shall be that part of the work on which, the subbase is placed or, in the absence of subbase, act as the base of the pavement structure. It shall extend to the full width of the road bed including the shoulders and laybyes as indicated on the Drawings or as specified herein.

109.2 CONSTRUCTION REQUIREMENT

109.2.1 Prior Work

Before commencing the work all culverts, drains, ditches including fully compacted backfill over them outlets for drainage, head walls/wing walls of culverts and any other minor structure below thirty (30) centimeters of existing subgrade level or all structures which will be below thirty (30) centimeters of newly placed subgrade level, shall be in such operative conditions as to ensure prompt and effective drainage and to avoid damage to subgrade by surface water. No work of subgrade preparation will be started before the prior work herein described have been approved by the Engineer.

109.2.2 Compaction Requirement

All materials down to a depth of 30 cm below the subgrade level in earth cut or embankment shall be compacted to at least 95 percent of the maximum dry density as determined according to AASHTO T-180 Method 'B' or 'D' whichever is applicable, or corresponding Relative Density as per D-4254-83 (ASTM).

109.2.3 Subgrade Preparation in Earth Cut

In case bottom of subgrade level is within thirty (30) cm of the natural ground, the surface shall be scarified, broken up, adjusted to moisture content and compacted to minimum density of ninety five (95) percent of the maximum dry density as determined by AASHTO T-180 Method D. Subsequent layer of approved material shall be incorporated to ensure that the depth of subgrade layer is thirty (30) cm.

In case, the bottom of subgrade is below the natural ground by more than Thirty (30) cm, the material above the top of subgrade shall be removed and subsequent layer of thirty (30) cm shall be scarified, broken up, adjusted to moisture content and compacted to the same degree of compaction as described above.

In case, unsuitable material is encountered at the sub grade level within a depth of thirty (30) cm, the same shall be removed in total and replaced by the approved material. The contractor shall be paid for removal of unsuitable material as per pay Item 106a and for replacement of approved material, the payment will be made under pay Item 108c.

109.2.4 **Subgrade Preparation in Rock Cut**

Excavation in rock shall extend to the subgrade level as shown on drawings. Rock shall be undercut nearly to required elevation and sections shown on the plans or as directed by the Engineer. Transverse and longitudinal profiles checked by template shall be accurate to the requirement. Cuts below subgrade level shall be backfilled with selected subbase material and compacted to minimum ninety eight (98) percent of the maximum dry density as determined by AASHTO T-180, method 'D'. No compensation shall be made to the Contractor for over-cut or remedial measures as described above.

No rock shall be higher than two (2) centimeters above the under cut section elevation. The under cut material shall be placed in embankment or disposed of at the direction of Engineer.

109.2.5 **Subgrade in Embankment**

When the subgrade is formed in embankment, its width shall be the full width of top of embankment and material placed in the upper part of embankment down to a depth of thirty (30) centimeters below subgrade level shall meet compaction requirement of 109.2.2. Soils having a minimum value of C.B.R of seven (7) percent and swell value of not more than 0.3 percent shall be used. C.B.R less than seven (7)% may be used in case, the design allows for it. Unsuitable material if encountered within the existing formation layer as per laboratory specified test, shall be removed, disposed of and replaced by suitable one as per direction of the Engineer of which the payment will be made under relevant items of work.

Rollers and other equipments of approved size and type, accepted by the Engineer, shall be used for compaction. Water shall be added to obtain optimum moisture content ; if necessary. Contractor shall ensure proper compaction in restricted areas by use of special equipments and rollers. No compensation shall be made for extra work due to restricted space.

Performance of this item of work shall not be paid for under this section but shall be deemed to be covered by the contract price for pay item 108a, through 108e, Formation of Embankment.

109.2.6 **Subgrade Level in Existing Road**

Where indicated on the Drawings or directed by the Engineer that the existing road surface is to be used as the subgrade, the correct elevation on which the base or subbase is to be laid shall be obtained, where necessary, either by means of leveling course or by excavation. The leveling course shall be constructed to the requirements of the Engineer and paid for under

the appropriate Pay Item involved. Excavation shall include disposal of any surplus material in the adjacent embankment or elsewhere as directed by the Engineer.

In case, the design level of subgrade is within 30 cm of the existing ground/road then the item shall be measured and paid accordingly.

109.2.7 **Subgrade reinforcement**

When the width of the existing pavement, either to be scarified or not, is insufficient to contain the subbase or base to be placed upon it, the Engineer may order to strengthen and support the subbase or base on one or both sides of the existing pavement. This work shall consist of the removal and disposal of any unsuitable material and its replacements with suitable material to such width and depth as required by the Engineer.

The excavated material shall, if declared suitable for use elsewhere in the embankment by the Engineer be so used, and payment for its removal shall be covered under the contract price of Pay Item No. 108a; if declared unsuitable it shall be disposed of and paid as provided in Item 106a. The finished compacted surface of the subgrade shall be as specified in Item 109.2.3.

109.2.8 **Protection of Completed Work**

Any part of the subgrade that has been completed shall be protected and kept well drained. Any damage resulting from carelessness of the Contractor shall be repaired as directed by the Engineer without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the subgrade. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repair. He shall limit the area of subgrade preparation to an area easily maintained with the equipment available. Subgrade preparation and subbase or base placing shall be arranged to follow each other closely. The subgrade, when prepared too soon in relation to the placing of the subbase, is liable to deteriorate, and in such case the Contractor shall, without additional payment, repair, reroll, or recompact the subgrade as may be necessary to restore it to the state specified herein.

109.2.9 **Templates and Straightedges**

The Contractor shall provide for the use of the Engineer, satisfactory templates and straightedges in sufficient numbers to check the accuracy of the work, as provided in these specifications and no subsequent work shall be permitted until the subgrade levels have been checked and approved by the Engineer. For tolerances, referred to the, "Table for Allowable Tolerances" in these specifications.

109.3 MEASUREMENT AND PAYMENT

109.3.1 Measurement

The quantity to be paid for shall be the number of square meters of subgrade prepared as herein before prescribed and accepted. Subgrade in rock cuts and on embankment not consisting of the existing road surface in fill area shall not be measured for direct payment.

Subgrade preparation on "Existing Surface" shall only be measured for payment when ordered by the Engineer.

109.3.2 Payment

The quantities, determined as provided above, shall be paid for at the contract unit price respectively, for each of the particular pay items listed below that is shown in the Bill of Quantities which prices and payment shall be full compensation for furnishing of material, water, equipment, tools, labour, and all other items necessary for completion of work.

Pay Item No.	Description	Unit of Measurement
109a	Subgrade preparation in Earth Cut	SM
109b	Subgrade preparation in Existing Road	
	i. Without any fill	SM
	ii. With fill less than 30 cms	SM

ITEM 110 IMPROVED SUBGRADE

110.1 DESCRIPTION

This work shall consist of the formation of the roadbed, under subbase or base course as the case may be, with an approved blend of materials, uniformly mixed, compacted, shaped and finished to the lines, grades and typical cross-sections shown on the Drawings, or in thickness as directed by the Engineer.

Improved subgrade as herein referred to may be defined as material suitable for embankment to which better quality of material is blended in proper proportion to improve its strength properties or performance.

110.2 MATERIAL REQUIREMENTS

The major component of improved subgrade shall consist of material conforming to Item 108.2 - "Material requirements for embankment."

The blending material shall be any soil that classifies as A-1(a), A-1(b), A-2-4 or A-3 according to AASHTO M-145 with PI of not more than 6.

The blended mixture when compacted to ninety five (95) percent of the maximum dry density determined by AASHTO T 180-D Method, shall exhibit a laboratory soaked CBR (96 hours) of not less than 20, or as specified in the drawings.

110.3 CONSTRUCTION REQUIREMENTS

110.3.1 Preparation

The surface of the roadbed on which the improved subgrade is to be constructed shall be compacted to the density specified under Item 108.3.1.

110.3.2 Proportioning of Materials

Prior to start of construction, the proportion of each material to be incorporated for improved subgrade shall be established as approved by the Engineer. The Engineer shall specify a single percentage of each material to be blended and shall establish the gradation of the resulting mixtures alongwith the ranges of permissible gradation tolerances to obtain the required CBR for the improved subgrade.

The blend proportions thus established shall apply only when each material to be used is obtained from same source. Should a change in source of material be made, a new proportion shall be established. When unsatisfactory results or other conditions make it necessary, the Engineer may require additional laboratory tests.

110.3.3 **Mixing and Spreading**

Improved subgrade may be constructed with any combination of machines or equipment that will yield results meeting these specifications.

a) Stationary Plant Method

The soil ingredients and water shall be mixed in an approved mixing plant (Pug Mill). The plant shall be equipped with feeding and metering devices that will add the materials to be blended in the specified quantities. Water shall be added during the mixing operation in the quantity required for proper compaction, which is approximately optimum moisture content plus or minus two (2) percent. The mixing time shall be that which is required to secure a uniform mixture. After mixing, the blended material shall be transported to the job site while it contains the sufficient moisture and shall be placed on the roadbed by means of an approved mechanical spreader. The mixture shall be spread at rate that will produce a uniform compacted thickness conforming to the required grade and cross-section. Compaction shall start as soon as possible after spreading and shall continue until the specified relative compaction is achieved.

b) Traveling Plant Method

The traveling plant shall be either a flat transverse shaft type or a windrow type pugmill. After the materials have been placed by a mechanical spreader or windrow sizing device the materials shall be uniformly mixed by the traveling mixing plant. During the mixing operation, water shall be added as necessary to bring the moisture content of the mixture to the percentage suitable for proper compaction.

c) Road Mix Method

The materials shall be transported to the site and spread in layers on the roadbed in the quantities required to produce the specified blend. After the materials for each lift have been spread, the materials shall be mixed by motor graders and other approved equipment until the mixture is uniform throughout.

During mixing operation, water shall be added as necessary to bring the moisture content to the proper percentage.

110.3.4 **Compaction**

Unless otherwise permitted by the Engineer based on the performance of the compacting equipment used as determined from the trial section, each layer of improved subgrade shall be placed in horizontal layers of uniform loose thickness not exceeding twenty (20) centimeters. Each layer shall be compacted to the density conforming to the requirements specified in Item 108.3.1.

In-place density determinations of the compacted layers shall be made in accordance with AASHTO T-191, T-238 or other approved methods.

110.3.5 **Trial Sections**

Prior to the formation of the improved subgrade, the Contractor shall construct three trial sections of 200 meter length one (1) for each blend of improved material proposed to be incorporated for improved subgrade, or as directed by the Engineer. The compacting equipment to be used in the trial sections shall be the same equipment that the Contractor intends to use for main work, accepted by the Engineer.

The object of these trials is to determine the proper moisture content, the relationship between the number of passes of compacting equipment, density obtained for the blended material, and to establish the optimum lift thickness that can be effectively compacted with the equipment used. No separate payment will be made for this work, which will be regarded as a subsidiary obligation of the Contractor under pay Item No. 110.

110.3.6 **Protection of Completed Work**

Any part of the completed improved subgrade shall be protected and well drained and any damage shall be repaired as directed by the Engineer without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the improved subgrade. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repair. He shall limit the improved subgrade preparation to an area easily maintained with the equipment available. Subgrade preparation and placement of succeeding layer to follow each other closely. The improved subgrade, when prepared too soon in relation to the placing of the layer above it, is liable to deteriorate, and in such case the Contractor shall, without additional payment, repair, reroll, or recompact the improved subgrade as may be necessary to restore it to the state specified herein.

110.3.7 **Templates and Straightedges**

The Contractor shall provide for the use of the Engineer, satisfactory templates and straightedges in sufficient numbers to check the accuracy of the work, as provided in these specifications and no subsequent work shall be permitted until the improved subgrade level have been checked and approved by the Engineer.

110.3.8 **Tolerance**

The allowable tolerances for the finished improved subgrade surface prior to placing the overlying subbase, base or asphaltic concrete course are given in the relevant, "Table for Allowable Tolerances" in these specifications.

110.4 MEASUREMENT AND PAYMENT

110.4.1 Measurement

The quantity of improved subgrade to be paid for shall be measured in square meter by the theoretical area covered in place as shown on the Drawings, completed and accepted improved subgrade in a thickness of 30 cms.

110.4.2 Payment

The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of improved subgrade for the pay item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, mixing, placing in layers, watering and compacting, labour, equipment, tools and incidentals necessary to complete the item.

Pay Item No.	Description	Unit of Measurement
110	Improved Subgrade	CM

EM 111 SOIL CEMENT STABILIZED SUBGRADE

111.1 DESCRIPTION

The work shall consist of performing all operations in connection with the formation of soil cement stabilized subgrade and all incidentals in accordance with the specifications and in conformity with the lines and level, grade and typical cross-sections shown on the plans or directed by the Engineer.

111.2 MATERIAL REQUIREMENTS

111.2.1 General

The mix in place method of construction shall only be applied to sites with naturally occurring sand, gravel or sand and gravel mixture. For the stationary plant method of construction the materials shall comply with the specifications or materials from any other source selected by the Contractor shall be subject to the Engineer's approval.

111.2.2 Soil

Soil used for cement stabilization shall be either "Silty or Clayey Soils" or sandy and gravely soils with the following characteristics

a) Silty and Clayey Soils

When this type of soil is used for cement stabilization it shall fulfill the following requirements.

i)	Liquid Limit (Max).	45%
ii)	Plastic Limit (Max).	20%
iii)	P.H. Value	Not less than 12
iv)	Soluble Sulphate Content max:	4%
v)	Soluble Chloride Content max:	8%

If the soil at site does not have P.H. value specified above, it shall be improved by adding calcium chloride upto two (2) percent by weight of the dry soil.

Soils, which don't meet above requirement, shall be subject to the approval of Engineer.

b) Sandy and gravely soils

Sandy and gravely soils used for cement stabilization shall fulfill the following requirements:

i)	Passing maximum size fifty (50) mm sieve	100%
ii)	Passing five (5) mm (No. 4) sieve	above 50%
iii)	Passing 0.4 mm (No. 36) sieve.	above 15%
iv)	Passing 0.075 mm (No. 200) sieve	below 5%
v)	Finer than 0.002 mm (Clay)	below 3%

Soil which do not meet above requirements shall be subject to the approval of Engineer after reviewing the laboratory testing results.

111.2.3 Cement

The Cement to be used for stabilization shall be Portland cement or sulphate resistant cement as directed by the Engineer according to the results of laboratory tests. Portland Cement shall conform to requirement of AASHTO M-85 while sulphate resistant cement shall conform to requirement of AASHTO M-74.

Immediately upon arrival to site, the Cement bags shall be stored in weather proof building to protect from dampness on raised platform. At the time of use, all cement shall be free flowing and free of lumps. Under normal circumstances cement shall not be stored for a period longer than four months. Any cement that has remained in store for a period in excess of four months, or of which there is any doubt as to its quality, shall be retested for specification requirements. No such cement shall be used in the works without the approval of Engineer.

111.2.4 Water

Water to be used shall be free from injurious quantities of oil, alkali, vegetable matter and salts. It shall not contain more than 1000 parts per millions of sulphates. In no case, water shall contain impurities to the extent that will cause change in setting time of cement by more than twenty five percent nor reduction in compressive strength of mortar after fourteen (14) days by more than five (5) percent when compared to results obtained with distilled water.

111.2.5 Mix Design Requirement in Laboratory

Before starting the work of stabilization, the proposed mix design showing exact percentage of cement and water to be used so as to obtain a mixture, shall be submitted by the contractor for the approval of Engineer. The mix proportions shall be such so as to satisfy the following requirements.

i) Mixture sample, stored in box, with maximum humidity of ninety five (95) % for twenty four (24) hours and submerged in water for two hours before crushing, shall have a minimum compressive strength of 17 kilogram per square centimeter.

ii) The maximum permissive swelling of volume shall be two (2) % and maximum loss in weight eight (8) % when tested in accordance with AASHTO T-135.

iii) Maximum permissible tolerance of cement and water content during construction shall be as under:-

Cement Content: Tolerance of ± 1.0 percent of that given in the mix design.
Water Content: 0 to (+)2% of that given in the mix design.

111.2.6 Composition of Mixture at Site

Soil shall be mixed with sufficient cement to obtain required crushing strength. The cement content shall be determined at the laboratory so that minimum compressive strength of mixture is thirty (30) Kg/square centimeter at seven (7) days. The moisture content of the mix cement stabilized material shall not be less than the optimum as determined by AASHTO T-134 Method and not more than two (2) percent above the optimum as determined by this test or such higher value as may be agreed by the Engineer on basis of preliminary trial.

111.3 CONSTRUCTION REQUIREMENTS

111.3.1 Mix in Place Method

The field equipments used for pulverizing and mixing the stabilized material shall be approved by the engineer on the basis of preliminary trials to ensure that the plant is capable of producing the required degree of mixing and uniformity of stabilized material to the full thickness of layer being processed. The mixers shall be equipped with a device for controlling the depth of processing and the mixing blades shall be maintained so that correct depth of mixing is obtained at all times. The cement shall be spread ahead of mixer by means of a cement spreader, fitted with a device to ensure a uniform and controllable rate of spread of cement both transversely and longitudinally.

Water shall be added to adjust moisture content of material to optimum for compaction using water sprayer in uniform and controllable manner both transversely and longitudinally.

The mixing machine shall be set so that, it slightly cuts edge of adjoining lane processed previously to ensure proper processing of all material throughout the depth of layer. The output of the mixing plant shall not be less than twenty five linear meters per hour measured longitudinally of completed stabilized layer in order to achieve satisfactory compaction.

111.3.2 Stationary Plant Method

The stationary plant shall be of the power driven paddle or pan type and may be of the batch or continuous type. In case the batch mixes are used, the appropriate measured quantity of material and cement shall first be placed in the mixer and then water be added as necessary to bring the moisture content of the resulting mixture with in the range specified above.

Care shall be taken with batch type paddle mixers to ensure that the cement is spread uniformly in the loading skip so that it is fed evenly along the mixing trough and that with both paddle and pan mixers, the cement is proportioned accurately by a separate weighing or proportioning device from that used for the material being stabilized. Mixing shall be continued until the mixture has the uniformity and mixing time will not be less than one (1) minute.

111.3.3 Compaction

Any modification to meet the specification shall be completed together with compaction, within one and a half (1 $^1/_2$) hours after mixing, or making good to deficient areas at contractor's expense. Thickness shall be as shown on the drawings or as directed by the Engineer and shall comply the following requirements.

Immediately after spreading and shaping operation, the mixture shall be thoroughly and uniformly compacted with approved rollers. Rolling shall continue until entire depth and width of subgrade is uniformly compacted to maximum density of Ninety five (95) % as tested in accordance with modified AASHTO T-134. Compaction shall be completed as soon as possible after mixing, normally within three hours, depending mainly on setting time of cement and weather conditions.

Compaction shall not be carried out after cement hydration and any soils material, which has been mixed or deposited after cement hydration, shall be removed and replaced with fresh mixed material.

After compaction, stabilized subgrade shall be protected against drying out by keeping it continuously damp or wet for a period of at least three (3) days or by coating with approved curing material. Surface shall be maintain in an acceptable condition at all times prior to the construction of sub-base.

No vehicular traffic shall run on the stabilized subgrade within a minimum curing period of seven days.

111.3.4 Tolerance

Tolerance in the thickness of compacted layers shall conform to as specified in the relevant, "Table for Allowable Tolerances" in these specifications.

111.4 MEASUREMENT AND PAYMENT

111.4.1 Measurement

The unit of measurement for payment shall be cubic meter of completed and accepted subgrade as measured in place. Measurement shall not include any areas in excess of that shown on the drawings, except the areas authorized by the Engineer in writing. Measurement of cement content used shall be the number of metric Ton used to stabilize subgrade. This quantity of Cement consumed shall not exceed the theoretical percentage established in the laboratory.

111.4.2 **Payment**

The measured quantity of stabilized subgrade determined as above shall be paid for at the contract unit price per cubic meter for a particular item listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing all labour, material, tool, plant, equipment, handling, mixing manipulating, placing, shaping, compacting, including necessary water for compaction, rolling, finishing; correcting unsatisfactory areas and unsatisfactory material; maintenance including protection of stabilized layers; and incidentals necessary for completion of work except cement consumed which shall be paid separately as measured above.

Pay Item No.	Description	Unit of Measurement
111a	Soil Cement stabilized Sub-grade	CM
111b	Cement content type.....	Ton

112.1 DESCRIPTION

The work shall consist of performing all operations in connection with construction of lime stabilized subgrade and all incidentals in accordance with these specifications and in conformity with lines and level, grade and typical cross-sections shown on the plans or as directed by the Engineer.

112.2 MATERIAL REQUIREMENTS

112.2.1 Soil

Naturally occurring heavy clay soils, clayey gravels or soils containing a sufficient proportion of clay or silty clay to enable satisfactory stabilization with lime shall be required for the Mix in Place method of construction and shall conform to properties as specified in Item 111.2, "Material Requirements" under soils cement stabilized sub grade. Materials from any other sources selected by the Contractor shall comply with the specification all as approved by the Engineer in case of stationary plant construction method.

Lime stabilization has been used successfully in clayey soils having plasticity index more than ten (10). This type of stabilization is applicable to that soil which contain a high percentage of clay or silty clay.

112.2.2 Lime

Lime to be used for stabilization shall be calcium hydroxide (slaked or hydrated lime) or Calcium oxide (quick lime) to the requirements for building lime as in table given below or lower quality lime produced from temporary burning pits or Kilns when approved by the Engineer.

Table 112/2

SPECIFICATION REQUIREMENT FOR LIME

Property	LIME	
	Quick Lime (Ca O)	Hydrated Lime Ca $(OH)_2$
Calcium or Magnesium Oxides	Not less than 92%	Not less than 95%
Carbon Dioxide-at Kiln	Not more than 3%	Not more than 5%
Carbon Dioxide-elsewhere	Not more than 3%	Not more than 7%

112.2.3 Water

Water used for lime stabilization shall be clean and free from injurious substances. Potable water is preferred and organic water is not permitted. It shall neither contain more than 1,000 parts per million of chlorides nor more than 1,300 parts per million of sulphates (SO_4). Water from doubtful sources shall not be used until tested as specified in AASHTO- T-26 and approved by the Engineer.

112.2.4 Mix Design in Laboratory

The mix design shall be worked out in the laboratory and it shall state the following field requirements:

(i) The percentage of lime and water (optimum content and tolerances)

(ii) The field density of lime stabilized mixture to minimum ninety five (95) percent of laboratory density established with modified AASHTO T-134 test.

(iii) The required results of the compressive strength in laboratory at 7 days shall not be less than ten (10) Kg/sq. cm.

112.2.5 Composition of Mixture at Site

Soil containing clay shall be mixed with sufficient lime, normally three (3) percent to eight (8) percent lime content, so that minimum compressive strength is seven (7) Kilogram force per square centimeters at seven (7) days. Moisture content of the lime stabilized material shall be not less than the optimum nor more than two (2) percent above the optimum as determined by Vibrating Hammer method test of BS 1924 (1975).

As a guide trials, lime content should be established starting with 1% of lime by weight of dry soil for each ten (10) percent of clay in soil.

112.3 CONSTRUCTION REQUIREMENTS

112.3.1 Stationary Plant Method

The construction requirements of this clause shall conform to as specified in sub item 111.3.2.

112.3.2 Mix in Place Method

The requirements of construction under this clause shall be in accordance with sub item 111.3.1.

112.3.3 **Precautionary Measures**

Keeping in view the caustic nature of calcium oxide (quick lime), special measures shall be taken in handling, since it will attack equipment corrosively and precautions shall also be taken against the risk of severe skin burns to personnel. Suitable handling methods shall be used such as fully mechanised or bottom dump handling equipment, and protective clothing worn by the operators. Working operations should take into account the wind direction to minimise the dust problem and consequent eye or skin irritation to any personnel involved in the vicinity. Even when calcium hydroxide (slaked or hydrated lime) is used, care must be taken against the effects of prolonged exposure to skin.

112.3.4 **Compaction Requirement**

Immediately upon completion of spreading and shaping operation, the mixture shall be thoroughly compacted with approved roller. Compaction shall be continued until the entire depth of subgrade is uniformly compacted to the maximum density of 95% as determined by modified AASHTO T-134.

If quick lime is used, it shall not be permitted to compact the layers immediately after spreading the lime, because the hydration of the lime will cause damage to the compacted layers. The time within which compaction shall be completed will be estimated in the laboratory. Dry density of compacted layers shall not be less than Ninety five (95) % of the maximum dry density determined in laboratory.

Compaction shall not take place after hydration of lime and any lime stabilized material that has been mixed and deposited after hydration of lime, shall be removed and replaced with fresh material, mixed and treated in accordance with the requirements of this clause.

Surface of subgrade shall be acceptable in all respects to specification, together with compaction with One and half (1.$^1/_2$) hours after mixing. Contractor will be responsible for any removal of or making good to deficient area without any extra payment. No vehicle or equipment shall be allowed to move over stabilised subgrade before initial setting of 7 days.

112.3.5 **Tolerance**

Tolerance for lime stabilized subgrade shall be as specified in the relevant, "Table for Allowable Tolerances" in these specifications.

112.3.6 **Weather Limitation**

The laying of lime courses shall be avoided as far as practicable during cold and wet weather and shall be suspended when free standing water is present on the surface. The stabilized material shall not be laid on any surface, which is frozen or covered with ice or snow, and laying shall cease when the atmospheric temperature reaches five (5) degree C. on a falling thermometer or as directed by the Engineer. If wet weather threatens to be prolonged, the manufacture and laying of stabilized mix shall be suspended.

112.4 MEASUREMENT AND PAYMENT

112.4.1 Measurement

The unit of measurement for payment shall be the cubic meter of the compacted and accepted subgrade as measured in place. Measurement shall not include any area in excess of that shown on the drawings, except the areas authorized by the Engineer in writing. Measurement of lime consumed shall be the number of metric Ton used to stabilize subgrade. This quantity of lime consumed shall not exceed the theoretical percentage established in the laboratory.

112.4.2 Payment

The measured quantity of stabilized subgrade determined as above shall be paid for at the contract unit price per cubic meter for a particular item listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing all labour, material, tool, plant, equipment; handling, mixing, manipulating, placing, shaping, compacting including necessary water for compaction, rolling, finishing; correcting unsatisfactory areas and unsatisfactory mixtures; maintenance including protection of stabilized layers; and incidentals necessary for completion of work except lime consumed which shall be paid separately as measured above.

Pay Item No.	Description	Unit of Measurement
112a	Lime Stabilized Subgrade	CM
112b	Lime	Ton

ITEM 113 BITUMEN STABILIZED SUBGRADE

113.1 DESCRIPTION

The work shall consist of performing all operations in connection with construction of bitumen stabilized subgrade and all incidentals in accordance with the specifications in conformity with the lines, grade, thickness and typical cross-sections shown on the plans or as directed by the Engineer.

113.2 *MATERIAL REQUIREMENTS*

113.2.1 Soil

This method will only apply to sites with naturally occurring non plastic material such as sand. If the material is brought at site, it shall be non-plastic having uniform gradation.

113.2.2 Bitumen

Bituminous material used for subgrade stabilization shall comply with the requirement as per relevant tables specified in item 301, "Asphaltic Materials" for hot mix asphaltic concrete or can be viscous cut back that requires heating in areas where moisture content of sand is high, necessitating heating and drying of sand.

In dry areas, where natural moisture content of sand is low, the bituminous binder shall be fluid cut back conforming the requirements as given in tables 301-3 and 301-4 respectively of item 301 "Asphaltic Materials".

Bitumen emulsion or foamed penetration grade bitumen can also be used subject to the approval of Engineer after trial test.

Bitumen-sand mixture for the grade of bitumen selected shall be ascertained by trial mixes using Marshall Test to determine the quantity of bitumen required using either heated or unheated sand. The quantity of bitumen required will generally lie between three (3) to six (6) percent by weight of dry sand, the higher proportions being required with fine-grained materials.

113.3 CONSTRUCTION REQUIREMENTS

Equipment, tools, and machines used for bitumen stabilized subgrade shall be subject to the approval of Engineer and shall be maintained in satisfactory working conditions all the times.

Mix in place method of bitumen stabilization will be subject to the approval of Engineer to ensure full control of bitumen content, uniform and thorough mixing and satisfactory processing of the material to the full depth of the layer. *For scarification of in situ material and spreading of Bituminous* material, grader with blade and bitumen distributor shall be used

The stabilized soil shall be left uncompacted after pulverization and mixing to allow for evaporation of volatile materials thus increasing stability and decreasing water absorption particularly in fine grained sand when temperature is low.

113.3.1 **Compaction**

Immediately after completion of spreading, aeration and shaping operation, the mixture shall be thoroughly compacted with rubber or pneumatic tyred rollers. Compaction shall continue until entire width and depth of subgrade is uniformly compacted to give soaked (96 hours) unconfined compressive strength according to design requirement to meet traffic loading. Steel wheeled tandem roller shall be used to carry out final rolling of compacted surface to eliminate the tyre marks.

To determine the efficiency of mixing, spreading, degree of compaction of equipment and suitability of construction method, trial sections as directed by the Engineer, shall be prepared by the contractor before main work of stabilization is started.

If thickness of compacted layer is less than 20 centimeters, it shall be laid as single operation where as if thickness of compacted stabilized layer is more than twenty centimeter, material shall be placed in two or more layers, each within the range of eight (8) to twenty (20) centimeters in compacted thickness.

The results of CBR test for measuring the strength of bitumen stabilized materials or cone stability test for designing bitumen-sand mixture shall not supersede those of Marshall Test unless agreed by the Engineer. In-situ density of compacted layer shall be determined using method as described by AASHTO - T-191, AASHTO - T-205 or AASHTO - T-238 and shall be minimum ninety five (95) % modified AASHTO according to the above mentioned methods.

Frequency of testing in field and in laboratory will be according to relevant schedule for sampling and testing of these specifications.

113.3.2 **Tolerance**

Compacted layer shall comply with the tolerance requirements as specified in relevant, "Table for Allowable Tolerances" in these specification.

113.3.3 **Weather Limitation**

The laying of bituminous courses shall be avoided as for as practicable during wet weather and shall be suspended when free standing water is present on the surface. The stabilized material shall not be laid on any surface, which is frozen or covered with ice or snow and laying shall cease when the air temperature reaches five (5) degree C on a falling thermometer. Laying shall not commence until the air temperature is at least five (5) degree C on a rising thermometer unless otherwise directed by the Engineer and also if wet weather threatens to be prolonged the manufacture and laying of stabilized mix shall be suspended.

113.4 MEASUREMENT AND PAYMENT

113.4.1 Measurement

The unit of measurement for payment shall be cubic meters of a given thickness of compacted and accepted subgrade as measured in place. Measurement shall not include any areas in excess of that shown on the drawings, except the areas authorized by the Engineer in writing. Measurement of bitumen binder used shall be the number of metric Ton used to stabilize subgrade. This quantity of bitumen consumed shall not exceed the theoretical percentage established in the laboratory.

113.4.2 Payment

Measured quantity of stabilized subgrade determined as above shall be paid for at the contract unit price per cubic meter for a particular item listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing all labour, material, tool, plant, equipment; handling, mixing, manipulating, placing, shaping, compacting including necessary water for compaction, rolling, finishing; correcting unsuitable areas and unsatisfactory material; maintenance including protection of stabilized subgrade layer and incidentals necessary for completion of work *except bitumen consumed* which shall be paid separately as measured above.

Pay Item No.	Description	Unit of Measurement
113a	Bitumen Stabilized Subgrade.	CM
113b	Bitumen Binder, type --	Ton

DRESSING AND COMPACTION OF BERMS

114.1 DESCRIPTION

This work shall consist of scarification of berms, which are undulated, or out of level. The existing material shall be scarified, watered, mixed and properly leveled and compacted according to specification described here under or as directed by the Engineer.

114.2 MATERIAL REQUIREMENTS

In this Item no fresh material is required, however, if fresh material is used it shall be measured and paid under other relative items of works.

114.3 CONSTRUCTION REQUIREMENTS

114.3.1 Dressing of berm without the use of extra material

In case the berms show undulation of more than 5 cms in level from the reconstructed pavement structure, the berms shall be scarified to a depth of 15 cm and material will be watered, mixed and compact with appropriate equipment approved by the Engineer.

114.3.2 Dressing of berm with the use of extra material

In case the difference of elevation of existing berm with respect to reconstructed road structure is less than 15 cm than additional material (to be measured under other items of work) shall be added to bring the level of berms in conformity with the lines and grades of the existing road. Existing and fresh material shall be properly mixed, watered and compacted as directed by the Engineer.

114.3.3 Compaction requirement

Compaction requirement of the fresh and existing material shall be in accordance with the type of material used in berms, as under:-

Depth in cm	Compaction requirement as per AASHTO T-180 (D).
0 - 15 (Top layer)	95% for common earth material
0 - 15 (Top layer)	100% for subbase material

114.3.4 **Compaction of slopes**

While reinstating/dressing of berms, it shall be ensured that compaction requirements are observed on slopes of the berms. The degree of compaction shall be as per direction of the Engineer.

114.4 MEASUREMENT AND PAYMENT

114.4.1 **Measurement**

Measurement under this item shall be made in square meter of berms dressed or compacted in accordance with theoretical lines, or sections shown on the drawings, or as per existing edge of road.

In case partial fresh material is used to compensate for shortage of material in the top layer the quantity of such material shall be measured by survey levels of existing ground and designed lines, grades or sections shown on the drawing.

The quantity of material thus measured shall be paid under other items of works of formation of embankment / subbase.

114.4.2 **Payment**

The payment of this item shall be made for at the contract unit price per square meter of dressed and compacted berm measured as above, for scarification, watering, mixing, rolling, labour, equipment, tools and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
114a	Dressing of berm without extra material.	SM
114b	Dressing of berm with extra material.	SM

ITEM 115 REINSTATEMENT OF SHOULDERS FROM BRICK KILN MATERIAL

115.1 DESCRIPTION

This work shall consist of furnishing and placing in single layer of Brick Kiln material on shoulders and to mechanically interlock by watering and rolling, in conformity with lines, grades and cross-sections shown on drawing.

115.2 MATERIAL REQUIREMENTS

The material shall conform to the following requirements.

115.2.1 Texture

The Kiln material shall be fully burnt having reddish brown/black colour. No unburnt or semi burnt material shall be allowed. The material shall behave like improved sub grade with following properties.

115.2.2 Gradation

The grading shall conform to the following limits.

Sieve Designation		Mass Percent Passing.
1"	(25 mm)	100
3/8"	(9.5 mm)	80-100
No. 10		50-85
No. 200		15-35

Note:- Coarser than 1" (25 mm) size material may be allowed upto five (5) percent by the Engineer.

115.2.3 Physical Requirements

The additional physical requirements of the kiln material will satisfy the following limits:-

1.	P.I. value.	6.0% max.
2.	Swelling Value.	0.20% max.
3.	Soaked C.B.R. (96 hours)	20% min.

115.3 CONSTRUCTION REQUIREMENTS

115.3.1 General

Material for shoulders, obtained and approved as provided above shall be placed and thoroughly mixed with water in horizontal layer of uniform thickness and in conformity with the lines, grades, sections and dimensions shown on the Drawings. The layer of loose material shall not be more than twenty (20) centimeters in thickness unless otherwise approved by the Engineer.

The compaction of the shoulders shall be carried out at the designated moisture content, consistent with the approved compacting equipment. Shoulder material that does not contain sufficient moisture to obtain the required compaction shall be given additional moisture by means of approved sprinklers and mixing operation. Material containing moisture more than necessary to obtain the required compaction may not, without written approval of the Engineer be incorporated in the shoulders until it has been sufficiently dried out. The drying of wet material may be expedited by discing or other approved methods.

Side slopes shall be neatly trimmed to the lines and slopes shown on the drawings or as directed by the Engineer, and the finished work shall be kept in a neat and acceptable condition.

115.3.2 Compaction

All material shall be compacted to a minimum ninety five (95) percent of the maximum dry density as determined according to AASHTO T-180 method 'B' or 'D' whichever is applicable. In place density determination of the compacted layer shall be made in accordance with AASHTO T-191 or other approved method.

115.4 MEASUREMENT AND PAYMENT

115.4.1. Measurement

The quantities to be paid for shall be the number in cubic meter by the theoretical volume of shoulders constructed according to designed lines and grades compacted in place and complete in all respect.

115.4.2 **Payment**

The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of Brick Kiln shoulder material for the pay item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, mixing, placing, watering and compacting, labour, equipment, tools and incidentals necessary to complete the item.

Pay Item No.	Description	Unit of Measurement
115	Reinstatement of Shoulders from Brick Kiln Material.	CM

SUBBASE

AND

BASE

SUBBASE AND BASE

ITEM 200 GENERAL

200.1 DESCRIPTION

The work shall consist of furnishing, spreading, and compacting graded subbase, base, asphaltic base course, crushed limestone base course, cement stabilized subbase and base course, lime stabilized subbase and bitumen stabilized subbase and base, crack relief layers, constructed on a prepared bed and all incidentals in accordance with these specification in conformity with the lines, grade thickness and typical cross-section shown on the drawing and/or as directed by the Engineer.

200.2 MATERIAL

The material shall consist of sand, gravel or a sand grave mixture obtained from the source approved by the Engineer. Material requirements for this work are specified under various items of the section.

200.2.1 Sampling and Testing

Adequate representative samples shall be submitted to Engineer for testing and preliminary approval not less than twenty days, before the intended material is to be used in the work. The material, when deemed necessary by the Engineer, shall be sampled and tested in his presence by the contractor for particular subbase, base course as called for in the specification of particular application and /or the bill of quantities, and/or as shown on the drawing, to assure conformance with the requirements of specification. Any material found not to conform with the requirements will be subject to rejection. All rejected material shall be removed and replaced with the material meeting the requirement, at no additional cost to the Client.

Preliminary approval of source shall not mean that all the material in the source is approved.

Sampling and testing, unless otherwise stated, shall be according to the standard methods prescribed in the latest edition of the American Association of State Highway and Transportation Officials (AASHTO) or standard specification and methods of sampling and testing, provided in latest version of American Society of Testing and Materials (ASTM). Any deviation from the methods and procedure prescribed therein may be made only as directed in writing by the Engineer as per relevant "Table for Sampling and Testing Frequency".

200.2.2 Selection of Place for Sampling

The selection of representative samples for testing shall be by "Random Sampling Method" by which every part of a lot or stockpile has equal chance to be selected. When it is necessary to sample stockpiles, every effort should be made to enlist the service of power equipment that is capable of exposing the material at various levels and locations. In sampling sand from stockpiles, the outer layer which may have become dry, causing segregation shall be removed and representative samples of the damp sand selected.

200.2.3 Number and Size of Samples

The number and size of sample required depends on the intended use of the material, the quantity of material involved and the variation both in quality and size of aggregate. A sufficient number of samples shall be obtained to cover all variations in the material. The quantities must be sufficient to provide for proper execution of the required tests.

200.2.4 Schedule for Sampling and Testing

The sampling frequency, acceptance limits, and other information for proper control of each work shall be as given in "Tables for Sampling and Testing Frequency" which will provide the minimum testing frequency under normal conditions. Where sampling frequencies are not given in the table they shall be as directed by the Engineer. Where frequencies are given as per layer or per strip this will mean the width of strip or layer being laid at any one item. If the materials or operations are variable and good control is difficult to maintain, greater sampling frequency may be taken as directed by the Engineer.

200.2.5 Tolerances

The allowable tolerances for the subgrade prior to placing the overlying courses, together with the allowable tolerances for the subbase and base are as specified in "Table for Allowable Tolerances", in these specifications.

200.3 PLANT & EQUIPMENT

All equipment, tools and machines used in the performance of work shall be maintained in satisfactory conditions at all times and be subject to the approval of the Engineer. List of recommended type of equipment is only for guidance of contractor. However contractor will be responsible to give required quality and workmanship through any type of equipment irrespective of any approval given by the Engineer.

200.4 **TRIAL STRIPS**

Contractor shall prepare trial strip for any item as appearing in this chapter, to establish the following.

a) Maximum thickness of loose layer, which can be laid.

b) Type of equipment to be used.

c) Watering and mixing procedures.

d) Number of passes required to satisfactorily compact the layer to required level.

e) Any other requirement ordered by the Engineer.

Engineer shall then inspect and test the Trial Strip and approve the procedure in writing, to carry out the work. However this approval shall not relieve the contractor from his contractual obligation.

ITEM 201 GRANULAR SUBBASE

201.1 DESCRIPTION

This item shall consist of furnishing, spreading in one or more layers and compacting granular subbase according to the specifications and drawings and/or as directed by the Engineer.

201.2 MATERIAL REQUIREMENTS

Granular subbase material shall consist of natural or processed aggregates such as gravel, sand or stone fragment and shall be clean and free from dirt, organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable subbase.

The material shall comply to the following grading and quality requirements:

a) The subbase material shall have a gradation curve within the limits for grading A, B, and C given below. However grading A may be allowed by the Engineer in special circumstances.

Grading Requirements for Subbase Material

Sieve Designation		Mass Percent Passing Grading	
mm	Inch	A	B
60.0	(2.1/2)	100	--
50.0	(2)	90-100	100
25.0	(1)	50-80	55-85
9.5	(3/8)	--	40-70
4.75	No. 4	35-70	30-60
2.0	No. 10	--	20-50
0.425	No. 40	--	10-30
0.075	No. 200	2-8	5-15

The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10%, respectively, passing (by weight) in a grain size analysis, curve.

b) The Material shall have a CBR value of at least 50%, determined according to AASHTO T-193. The CBR value shall be obtained at a density corresponding to Ninety eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D.

c) The coarse aggregate material retained on sieve No. 4 shall have a percentage of wear by the Los Angeles Abrasion (AASHTO T-96) of not more than fifty (50) percent.

d) In order to avoid intrusion of silty and clayey material from the subgrade in the subbase, the ratio D15 (Subbase)/D85 (Subgrade) should be less than 5.

Where D85 and D15 are the particle diameters corresponding to eighty five (85) % and fifteen (15) %, respectively, passing (by weight) in a grain size analysis, curve.

e) The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than two third of the fraction passing the 0.425 mm (No. 40) sieve. The fraction passing the 0.425 mm sieve shall have a liquid limit of not greater than 25 and a plasticity index of 6 or less.

f) If over-size is encountered, screening of material at source, shall invariably be done, no hand picking shall be allowed, however hand picking may be allowed by the Engineer, if over-size quantity is less than 5% of the total mass.

g) Sand equivalent for all classes shall be 25 min.

201.3 CONSTRUCTION REQUIREMENTS

201.3.1 Spreading

Granular subbase shall be spread on approved subgrade layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse or fine materials.

Granular subbase shall be deposited on the roadbed or shoulders in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the subbase material. In case any material is to be added to compensate for levels, the same shall be done after scarifying the existing material, to ensure proper bonding of additional material.

When the required thickness is fifteen (15) cm or less, the aggregates may be spread and compacted as one layer, but in no case shall a layer be less than seven and one half (7.5) centimeters thick. Where the required thickness is more than 15 cm, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness, but in any case the maximum compacted thickness of one layer shall not exceed 15 cm. All subsequent layers shall be spread and compacted in a similar manner.

Granular subbase shall be spread with equipment that will provide a uniform layer conforming to the specified item both transversely and longitudinally within the tolerances as specified in "Table for Allowable Tolerances" in these specifications. No hauling or placement of material will be permitted when, in the judgment of the Engineer, the weather or road conditions are such that the hauling operation will cause cutting or rutting of subgrade or contamination of sub base material.

201.3.2 Compaction Trials

Prior to commencement of granular subbase operation, contractor shall construct a trial length, not to exceed, five hundred (500) meters and not less than two hundred (200) meters with the approved subbase material as will be used during construction to determine the adequacy of the contractor's equipment, loose depth measurement necessary to 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 material. For details, refer to clause 1.20 (General) of these specifications.

201.3.3 Compaction

The moisture content of subbase material shall be adjusted prior to compaction, by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the specified compaction.

The subbase material shall be compacted by means of approved vibrating rollers or steel wheel rollers (rubber tyred rollers may be used as a supplement), progressing gradually from the outside towards the centre, except on superelevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface free from ruts or ridges and having proper section and crown. Rolling shall continue until entire thickness of each layer is thoroughly and uniformly compacted to the specified density.

Any area inaccessible to rolling equipment shall be compacted by means of hand guided rollers, plate compactors or mechanical tampers, where the thickness in loose layer shall not be more than 10 cm.

If the layer of subbase material, or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and recompact the material before succeeding layer of the pavement structure is constructed.

Immediately prior to the placing of first layer of base course the subbase layer (both under the traveled way and the shoulders) shall conform to the required level and shape. Prior to placing the succeeding layers of the material, the top surface of each layer shall be made sufficiently moist to ensure bond between the layers. The edges or edge slopes shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the plans.

No material for construction of the base shall be placed until the subbase has been approved by the Engineer.

201.3.4 **Compaction requirements**

The relative compaction of each layer of the compacted subbase shall not be less than Ninety eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D. The field density shall be determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19 mm sieve) as directed by the Engineer Also for adjustment of any material retained on 4.75 mm sieve, AASHTO Method T-224 shall be used

201.3.5 **Moisture Content Determination**

As it is customary in the project laboratories that small samples of materials are placed in ovens for moisture determination for proctor, following precautions are necessary to ensure proper compaction results.

a) Same size of sample is placed in oven for moisture determination in case of laboratory density (Proctor) and field density.

b) Moisture content for calculation of field density and proctor shall be observed on material passing 4.75 mm sieve.

201.3.6 **Tolerance**

The subbase shall be compacted to the desired level and cross slopes as shown on the drawings. The allowable tolerance shall be according to the "Table for Allowable Tolerances" in these specifications.

201.4 **MEASUREMENT AND PAYMENT**

201.4.1 **Measurement**

The quantity of subbase to be paid for shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed granular subbase course. No allowance will be given for materials placed outside the theoretical limits as shown on the cross-sections.

201.4.2 Payment

The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of granular subbase, for the Pay Item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete the item.

Pay Item No.	Description	Unit of Measurement
201	Granular Subbase	CM

202.1 DESCRIPTION

This item shall consist of furnishing, spreading and compacting one (1) or more layers of aggregate base on a prepared subgrade, subbase, or existing road surface, in accordance with the specifications and the drawings and/or as directed by the Engineer.

202.2 MATERIAL REQUIREMENTS

Material for aggregate base course shall consist of crushed hard durable gravel, rock or stone fragments. It shall be clean and free from organic matters, lumps of clay and other deleterious substances. The material shall be of such a nature that it can be compacted readily under watering and rolling to form a firm, stable base for both flexible and rigid pavements.

The aggregate base shall comply to the following grading and quality requirements.

a) The gradation curve of the material shall be smooth and within the envelope limits for Grading A or B given below.

Grading Requirements for Aggregate Base Material

Sieve Designation		Mass Percent Passing Grading	
mm	Inch	A	B
50.0	2	100	100
25.0	1	70-95	75-95
9.5	3/8	30-65	40-75
4.75	No. 4	25-55	30-60
2.00	No. 10	15-40	20-50
0.425	No. 40	8-20	12-25
0.075	No. 200	2-8	5-10

The material shall be well graded such that the coefficient of Uniformity D60/D10 shall be greater than four (4).

b) Crushed Aggregate (material retained on sieve NO. 4) shall consist of material of which at least ninety (90) percent by weight shall be crushed particles, having a minimum of two (2) fractured faces.

c) The Coarse aggregate shall have a percentage of wear by the Loss Angeles Abrasion test (AASHTO T-96) of not more than forty (40).

d) The material shall have a loss of less than twelve (12) percent when subjected to five cycles of the Sodium Sulphate Soundness test according to AASHTO T-104.

e) The sand equivalent determined according to AASHTO T-176 shall not be less than 45 and the material shall have a Liquid limit of not more than twenty five (25) and a plasticity Index of not more than 6 as determined by AASHTO T-89 and T-90.

f) The material passing the 19 mm sieve shall have a CBR value of minimum eighty (80) percent, tested according to the AASHTO T 193. The CBR value shall be obtained at the maximum dry density determined according to AASHTO T 180, Method D.

g) Laminated material shall not exceed 15% of total volume of Aggregate Base Course.

202.2.1 Filler for Blending

If filler, in addition to that naturally present in the aggregate base material is necessary for meeting the grading requirement or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the crushing plant or in a pugmill unless otherwise approved. The material for such purpose shall be obtained from sources approved by the Engineer. The material shall be free from organic matter, dirt, shale, clay and clay lump or other deleterious matter and shall conform to following requirement.

AASHTO Sieve	Percent Passing
3/8 Inch	100
4	85-100
100	10-30
Plasticity Index (AASHTO T-90)	6 maximum
Sand Equivalent (AASHTO T-176)	30 minimum.

However the combined aggregates prepared by mixing the coarse material and filler shall satisfy the requirements as mentioned in clause 202.2 above.

202.3 CONSTRUCTION REQUIREMENTS

202.3.1 Preparation of surface for Aggregate base course

In case crushed aggregate base is to be laid over prepared sub base course, the subbase course shall not have loose material or moisture in excess to optimum moisture content.

Spreading shall conform in all respects to the requirements specified under this heading in Item 201 - Subbase (201.3.1).

202.3.2 **Compaction**

Compaction process shall conform in all respect to the requirements specified under this heading in Item 201 (201.3.3).

202.3.3 **Compaction Requirement**

The relative compaction of each layer of the compacted base shall not be less than 100 percent to the maximum dry density determined according to AASHTO T-180, Method D (Modified). The field density shall be determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19 mm sieve) as directed by the Engineer. Also for adjustment of any material retained on 4.75 mm sieve, AASHTO Method T-224 shall be used

Completed base course shall be maintained in an acceptable condition at all times until prime coat is applied. When base course is to carry traffic for an indefinite length of time before receiving surfacing, the contractor shall maintain the surface until final acceptance and shall prevent reveling by wetting, blading, rolling and addition of fines as may be required to keep the base tightly bound and leave a slight excess of material over the entire surface which must be removed and the surface finish restored before application of prime coat.

202.3.4 **Moisture Content Determination**

Moisture content determination shall conform in all respects to the requirements specified under clause 201.3.5 for subbase.

202.3.5 **Trial Sections**

Prior to commencement of aggregate base course operations, a trial section of two hundred (200) meters minimum, but not to exceed five hundred (500) meters shall be prepared by the contractor using same material and equipment as will be used at site to determine the adequacy of equipment, loose depth measurement necessary to result in the specified compacted layer depths, field moisture content, and relationship between the number of compaction passes and the resulting density of material. For details refer to clause 1.20 (General) of these specifications.

202.3.6 **Tolerance**

The completed base course shall be tested for required thickness and smoothness before acceptance. Any area having waves, irregularities in excess of one (1) cm in three (3) M or two (2) cm in fifteen (15) M shall be corrected by scarifying the surface, adding approved material, reshaping, re-compacting and finishing as specified. Skin patching of an area without scarifying the surface to permit proper bonding of added material shall not be permitted. The allowable tolerances shall be according to the "Table for Allowable Tolerances" in these specifications.

202.3.7 Acceptance, Sampling and Testing

Acceptance of sampling and testing with respect to materials and construction requirements shall be governed by the relevant, "Table for Sampling and Testing Frequency" or as approved by the Engineer.

202.4 MEASUREMENT AND PAYMENT

202.4.1 Measurement

The quantity of aggregate base to be paid for, shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed crushed aggregate base course. No allowance will be given for materials placed outside the theoretical limits as shown on the cross sections.

202.4.2 Payment

The accepted quantities measured as above shall be paid for at the contract unit price per cubic meter of aggregate base, for the item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
202	Aggregate Base.	CM

203.1 DESCRIPTION

This work shall consist of furnishing of plant, labour, equipment and material and performing all operations in connection with the construction of an asphaltic plant-mix base course on a previously constructed and accepted subgrade, subbase or base course, subject to terms and conditions of the Contract, *and in strict accordance with this Section of the Specification*, the Drawings and the directions of the Engineer.

203.2 MATERIAL REQUIREMENTS

203.2.1 Mineral Aggregate

Mineral aggregate for bituminous base course shall consist of coarse aggregate, fine aggregate and filler material, if required, all conforming with the following requirements:

Coarse aggregate which is the material retained on AASHTO No. 4 sieve shall consist of crushed rock, crushed gravel or crushed boulder. It shall be *clean, hard, tough, sound, durable, free from decomposed stones, organic* matter, shale, clay lump or other deleterious substances. Rock or boulders from which coarse aggregate is obtained, shall be of uniform quality throughout the quarry.

The crushing shall be so regulated that at least ninety five (95) percent by weight of material retained on AASHTO No. 4 sieve shall consist of pieces with at least two (2) mechanically fractured faces, and when tested for stability of bituminous mix shall show satisfactory stability.

Fine aggregate which is material passing No. 4 sieve, shall consist of 100% crushed material from rock or boulder. No natural sand will be allowed in the mix.

When the combined grading of the coarse and fine aggregates is deficient in material passing No. 200 sieve, additional filler material shall be added. The filler material shall consist of finely divided rock dust, hydrated lime, hydraulic cement or other suitable mineral matter. However, in case the coarse aggregates are of quartizitic nature, then hydrated lime or a better material shall be allowed. At the time of use, it shall be sufficiently dry to flow freely. Filler material shall conform to following gradation:

US Standard Sieve	Percent Passing by Weight
No. 30	100
No. 50	95-100
No. 200	70-100

The coarse and fine aggregates shall meet the following applicable requirements:

a) The percentage of wear by the Los Angeles Abrasion test (AASHTO T 96) shall not be more than forty (40).

b) The loss when subject to five cycles of the Sodium Sulphate Soundness test (AASHTO T 104) shall be less than twelve (12) percent.

c) The Sand Equivalent (AASHTO T 176) determined after all processing except for addition of asphalt cement shall not be less than forty five (45).

d) Fine aggregates shall have a liquid limit not more than twenty five (25) and a Plasticity Index of not more than six (6) as determined by AASHTO T 89 and T-90.

e) The portion of aggregate retained on the 9.5 mm (3/8 inch) sieve shall not contain more than 15 percent by weight of flat and/or elongated particles (ratio of maximum to minimum dimensions = 2.5:1).

f) Stripping test shall be performed on coarse aggregates as described under AASHTO T-182 and only that material shall be allowed which qualifies the test.

g) The coarse aggregates shall be checked if desired by the Engineer for cationic and anionic behaviour so that their affinity with the bitumen to be used is verified.

h) Petrographic examination of the coarse aggregate shall be conducted if so directed by the Engineer.

203.2.2 Asphaltic Material

Asphalt binder to be mixed with the aggregate to produce asphaltic base shall be asphalt cement having penetration grade 40-50, 60-70 or 80-100 as specified by the Engineer. Generally it will meet the requirements of AASHTO M - 20.

203.2.3 Asphalt Concrete Base Course Mixture

The composition of the asphaltic concrete paving mixtures for base course shall conform to Class A and/or Class B shown in the following table

TABLE 203-1

Combined Aggregate Grading Requirements

Mix Designation	Class A	Class B
Use	Leveling/Base	Leveling/Base
Compacted Thickness	70 - 90 mm	50 - 80 mm
U.S. Standard Sieve Size Percent passing by weight		
2" (50 mm)	100	–
1.1/2" (38 mm)	90 - 100	100
1" (25 mm)	–	75 - 90
3/4" (19 mm)	56 - 75	65-80
1/2" (12.5 mm)	–	55 - 70
3/8" (9.5 mm)	–	45 - 60
No. 4 (4.75 mm)	23 - 40	30 - 45
No. 8 (2.38 mm)	15 - 30	15 - 35
No. 50 (0.300 mm)	4 - 10	5 - 15
No. 200 (0.075 mm)	3 - 6	2 - 7
Asphalt Content weight percent of total mix	3 (Minimum)	3 (minimum)

The asphalt concrete leveling / base course mixture shall meet the following Marshall Test Criteria.

Compaction, number of blows each end of specimen.....	75 ? which Traffic
Stability.....	1000 Kg (Min.)
Flow, 0.25 mm (0.01 in.).....	8-14
Percent air voids in mix.....	4-8
Percent voids in mineral aggregates.....	According to Table 5.3 MS-2, Asphalt institute, sixth edition 1993.
Loss in Stability.....	25 percent (Max.)

Mixes composed of larger size aggregates with maximum size upto 38 mm (1.5 inches) will be prepared according to modified Marshall method as per MS-2 Asphalt institute, sixth edition, 1993 or the latest edition. The procedure is basically the same as the original method except for following differences that are due to the larger specimen size that is used:

a) The hammer weighs 10.2 kg (22.5 lb.) and has a 149.4 mm (5.88 inches) flat tamping face. Only mechanically-operated device is used for the same 457 mm (18 inches) drop height.

b) The specimen has a 152.4 mm (6 inches) diameter by 95.2 mm (3.75 inches) height.

c) The batch weights are typically of 4 Kg.

d) The equipment for compacting and testing (molds and breaking heads) are proportionately larger to accommodate the larger specimens.

e) The mix is placed in the mold in two approximately equal increments, with spading performed after each increment to avoid honey-combing.

f) The number of blows needed for the larger specimen is 1.5 times (75 or 112 blows) of that required for the smaller specimen (50 or 75 blows) to obtain equivalent compaction.

g) The design criteria shall be modified as well, the minimum stability shall be 2.25 times and the range of flow values shall be 1.5 times normal-sized specimens.

h) Similar to the normal procedure, following values shall be used to convert the measured stability values to an equivalent value for a specimen with a 95.2 mm (3.75 inches) thickness, if the actual thickness varies:

Approximate Height mm	(inches)	Specimen Volume (Cubic cm)	Correlation Ratio
88.9	(3 1/2)	1608 to 1626	1.12
90.5	(3 9/16)	1637 to 1665	1.09
92.1	(3 5/8)	1666 to 1694	1.06
93.7	(3 11/16)	1695 to 1723	1.03
95.2	(3 3/4)	1724 to 1752	1.00
96.8	(3 13/16)	1753 to 1781	0.97
98.4	(3 7/8)	1782 to 1810	0.95
100.0	(3 15/16)	1811 to 1839	0.92
101.6	(4)	1840 to 1968	0.90

203.2.4 **Job-Mix Formula**

At least one (1) week prior to production, a Job-Mix Formula (JMF) for the asphaltic base course to be used for the project, shall be established jointly by the Engineer and the Contractor in the project laboratory. Job mix formula shall combine the mineral aggregates and asphalts in such proportion conforming to specification requirements.

The JMF shall be established by MARSHALL Method of Mix Design according to the procedure prescribed in the Asphalt Institute Manual Series No. 2 (MS-2), sixth edition 1993, or the latest Edition.

The JMF, with the allowable tolerances shall be within the range specified in Item 203.2.3. Each JMF shall indicate a single percentage of aggregate passing each required sieve size and a single percentage of bitumen to be added to the aggregate.

The ratio of wt. of filler (passing sieve No. 200) to that of asphalt shall range between 1–1.5 for hot climate areas with temperature more than 40°C.

After the JMF is established, all mixtures furnished for the project represented by samples taken from the asphalt plant during operation, shall conform thereto Moreover upon receiving the job-mix, approved by the Engineer, the Contractor shall adjust his plant to proportion the individual aggregates, mineral filler and asphalt to produce a final mix that, when compared to job mix formula shall be within the following limits.

Maximum Variation of Percentage of Materials

Retained No. 4 and larger	± 7.0%
Passing No. 4 to No. 100 sieve	± 4.0%
Passing No. 200	± 1.0%

Asphalt Content

Weight percent of total mix	± 0.3%

In addition to meeting the requirements specified in the proceeding items, the mixture as established by the JMF shall also satisfy the following physical property

Loss of Marshall stability by immersion of specimen in water at sixty (60) degree centigrade for 24 hours as compared with stability measured after immersion in water at 60 degrees centigrade for 20 minutes shall not exceeds twenty five (25) percent. If the mixture fails to meet this criterion, JMF shall be modified or an antistripping agent shall be used.

Should a change of sources of materials be made, a new Job Mix Formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, a new Job Mix Formula will be required.

203.3 CONSTRUCTION REQUIREMENTS

203.3.1 Bituminous Mixing Plant

Plants used for the preparation of bituminous mixtures shall be "Batching Plants" conforming to AASHTO M 156, and of adequate capacity, coordinated and operated to produce a mixture within the limits of these specifications. Plant shall have minimum three cold bins and at least 3.5 decks of hot sieves.

203.3.2 Preparation of Aggregates

Before being fed to the dryer, aggregates for the asphaltic base courses shall be separated into three or more sizes and stored separately in cold bins. One bin shall contain aggregate of such size that eighty (80) percent will pass sieve No. 4, and the other two bins shall contain aggregate of such sizes that eighty (80) percent will be retained on sieve No. 4. Should fine material, be incorporated in the mix, separate bin shall be provided in addition to the three bins mentioned above. If filler is used as a separate component it will also be stored and measured separately and accurately before being fed into the mixer through filler screw mechanism.

Asphalt cement shall be heated within a temperature range of hundred and thirty five to hundred and sixty three (135-163) degrees centigrade at the time of mixing. Asphalt cement heated above maximum shown shall be considered overheated and shall be rejected and removed from job site.

Dried aggregate weighed and drawn to pugmill shall be combined with proportionate quantity of asphalt cement according to the job mix formula. Temperature of asphalt, except for temporary fluctuations, shall not be lower than fifteen (15) degrees centigrade below the temperature of the aggregate, at the time, the two materials enter into the pugmill.

For placing the materials in bins or in moving them from bins to the dryer, any method which causes segregation or uncontrolled combination of materials of different grading, shall be discontinued and the segregated or degraded materials shall be prescreened for reuse.

Each aggregate ingredient shall be heated and dried at temperature not to exceed hundred and sixty three (163) degrees centigrade. If aggregate contain sufficient moisture to cause foaming in the mixture or their temperature is in excess of hundred and sixty three (163) degrees centigrade, they shall be removed from the bins and returned to their respective stock piles. In no case, shall the temperature of asphaltic mix exceed 163 degree centigrade when discharged from the pugmill.

Immediately after heating, the aggregates shall be screened to required sizes and stored in separate hot bins for batching and mixing with bituminous material.

Asphalt plant shall have minimum three and half (3 $^1/_2$) sieve decks to effectively control the gradation of hot bins.

203.3.3 **Hauling Equipment**

Dump truck used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with an approved material to prevent adhering of material to the beds. Each truck shall have a cover of canvas or of other suitable material of sufficient size as to protect the mixture from the weather. The mixture will be delivered on the road at a temperature not less than hundred and thirty (130) degree C. Drivers of dump trucks will ensure that while reversing the vehicles. paver is not pushed back producing a hump.

203.3.4 **Bituminous Pavers**

Bituminous pavers shall be self-contained, power-propelled units, provided with an automatically controlled activated screed or strike-off assembly, heated if necessary, capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thickness shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing course of bituminous plant mix material in widths shown on the plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The paver shall be equipped with automatic feed controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

The screed or strike-off assembly shall be capable of producing a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

When laying the mixtures, the paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture. The paver shall be operated at speeds which will give the best result for the type of power being used.

The mixed material shall be delivered to paver in time to permit completion of spreading, finishing and compaction of mixture during day light hours.

The paver shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed and providing the automatic signals which operates the screed to maintain the desired grade and transverse slope. The sensor shall be so constructed that it will operate from a reference line or a ski-like arrangement.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent variation.

Manual operation will only be permitted in the construction of irregularly shaped and minor areas.

Whenever a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods in order to allow the contractor to use the asphalt already produced at the plant or in transit, provided this method of operation will produce results otherwise meeting the specifications.

Reference lines will be required for both outer edges of the traveled way for each main line roadway for vertical control. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines or by means of a ski and a slope control device or a dual ski arrangement. When the finish of the grade prepared for paving is superior to the established tolerance and, when in the opinion of the Engineer, further improvement to the line, grade, cross sections and smoothness can best be achieved without the use of the reference line, a ski-like arrangement may be substituted subject to the approval of the Engineer. The use of the reference lines shall be reinstated immediately whenever the Contractor fails to maintain a superior pavement. The Contractor shall furnish and install all pins, brackets, tensioning devices, wire and accessories necessary for satisfactory operation of the automatic control equipment.

203.3.5 Rollers

Rollers shall be steel wheel, pneumatic tyre and vibratory, or a combination thereof. The roller(s) shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Vibratory rollers shall be acceptable for bituminous mixture compaction. The use of equipment, which results in excessive crushing of the aggregate will not be permitted.

203.3.6 **Preparation of Base or Existing Pavement Surface**

Before spreading materials, the surface of base or existing pavement on which the mix is to be placed shall be conditioned by application of a prime or tack coat as specified.

After a prime coat is applied, it shall be left undisturbed not less than twenty four (24) hours. The Contractor shall maintain the primed surface until the mix material has been placed. This maintenance shall include the spreading of sand or other approved material, if necessary to prevent adherence of the prime coat to the tyres of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the mix is placed, to the satisfaction of Engineer. It shall be ensured that primed surface is not in tacky condition, when premix is laid.

After a tack coat is applied, it shall be allowed to dry until it is in the proper condition of tackiness to receive the mix. The tack coat shall be applied only as far in advance of the placing of mix, as is necessary to obtain the proper condition of tackiness. Any breaks in the tack coat shall be repaired.

When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross-section by leveling course as directed. The leveling course mixture shall conform to the requirements of Item 203.2.

A thin coating of bituminous material shall be sprayed on contact surface of curbing, gutters, manholes, and other structures, prior to the bituminous mixture being placed against them.

203.3.7 **Spreading and Finishing**

The mixture shall be laid upon an approved surface, spread and struck off to the section and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

The longitudinal joint in one layer shall offset to that in the layer immediately below, by approximately 15.0 cm; however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two lanes of width, or at lane lines if the roadway is more than 2 lanes in width.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools. For such areas the mixture shall be dumped, spread and screeded to give the required compacted thickness, ensuring even distribution of coarse and fine material.

When production of the mixture can be maintained and wherever practical, pavers shall be used in echelon to place the wearing course in adjacent lanes and compacted to form a surface without lateral joint.

All mixtures shall be spread at a temperature of not less than hundred and thirty (130) degree C and all initial rolling or tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 165 degree C and 190 degree C. The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling or finishing.

203.3.8 Compaction

After spreading and strike off and as soon as the mix condition permits the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted. Rolling shall not be prolonged when cracks appear on the surface.

Initial or breakdown rolling shall be done by means of either a tandem steel roller or three wheeled steel roller. Rolling shall begin as soon as the mixture will bear the roller without undue displacement.

The number and weight of rollers shall be sufficient to obtain the required compaction while the mixture is still in workable condition. The sequence of rolling and the selection of roller types shall provide the specified pavement density. Initial rolling with a tandem steel roller or a three-wheeled steel roller shall follow the paver as closely as possible.

Unless otherwise directed, rolling shall begin at the lower side and proceed longitudinally, parallel to the road centerline, each trip overlapping one-half of the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline. Intermediate rolling with a pneumatic tyred roller shall be done behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In no case shall the temperature be less than hundred and twenty (120) degree C. for initial break down rolling while all other compaction operations shall be completed before the temperature drops down to hundred and ten (110) degree C.

Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver. Rolling shall be continued until all roller marks are eliminated and a minimum density of Ninety seven (97) percent of a laboratory compacted specimen made from asphaltic material obtained for daily Marshall density is achieved.

Any displacement resulting while reversing the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

To prevent adhesion of the mixture to the rollers, wheels of rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers. On depressed areas, tempers be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective in finish or density shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

Sequence of laying and compaction of premix shall be so managed, that a long time does not elapse between successive dump trucks, which may cool down the uncompacted premix, between paver and compacted asphalt below 120° C.

203.3.9 **Frequency of Testing for Cores**

One core shall be taken for each 100 linear meter of each lane of Asphaltic Base, or fraction thereof, in special cases. If the core so taken is failed against the specified 97% density, then two (2) additional cores shall be taken in the longitudinal alignment of the road at an interval of three (3) meters on either side with respect to the failing core and shall be tested against field density. If all the three cores give an average of 97% compaction, and the individual compaction of the core is not less than ninety five (95) percent, then the compaction is acceptable. If average of the cores further fails against compaction, then retake the cores at a distance of fifteen (15) meters on either side and compaction shall be checked for all the five cores in the same fashion. If average of five cores is 97%, the area will be accepted. In case average is ninety six 96% or more, then Engineer may withhold the payment in full or partly and observe behaviour during maintenance period, for the release of payment or otherwise. In case of failure of the average of these five cores giving average compaction of less then 96%, the failed area shall be removed and subsequently be replaced by specified mix in an approved manner at the expense of contractor.

203.3.10 **Surface Tolerances**

After completion of final rolling, the finished surface shall be tested for smoothness with three (3) meters straightedge by Engineer at selected locations. The variation of surface from testing edge of straight edge between any two (2) contacts with the surface shall at no point exceed six (6) millimeters when placed either parallel or perpendicular to centreline of roadway.

Any irregularities that exceed the specified tolerances or that retain water on the surface shall be corrected by removing the defective area and replacing with new asphaltic base course without additional cost to the Employer.

203.3.11 **Base Thickness Tolerances**

For determination of thickness, one (1) core for each hundred (100) linear meter of each lane shall be taken. Unless otherwise permitted, cores extracted for thickness measurement shall not be used for density determination and density cores shall not be used for thickness measurements.

When layer thickness of asphaltic base course is deficient by more than five (5) mm from that specified in the Drawings, the deficiency shall be removed with satisfactory base course material and/or made up by additional asphalt concrete wearing course thickness without extra cost to the Employer. If such remedial action is authorised, revised thickness determinations shall be made by measurements of new cores taken after placing of "Asphaltic Wearing Course" material or as directed by the Engineer. If base course deficiencies are corrected in this manner, full payment for the "Asphaltic Base Course" will be made to the Contractor, but no additional payment will be made for the increase in thickness of the "Asphaltic Wearing Course".

203.3.12 **Acceptance Sampling and Testing**

Acceptance of samples and testing of materials and construction requirements, shall be governed by the relevant, "Table for Sampling and Testing Frequency" or as approved by the Engineer.

203.3.13 **Weather Limitations**

Hot asphaltic mixtures shall be placed only when the air temperature is four (4) degrees centigrade or above and no asphalt shall be laid under foggy or rainy weather or over moist surface.

203.3.14 **Trial Section**

Contractor shall prepare a trial section before the start of work in light of procedure given in clause 1.20 (General).

203.4 **MEASUREMENT AND PAYMENT**

203.4.1 **Measurement**

The quantities for asphaltic leveling / base course will be measured by volume in cubic meters compacted in place. Measurement shall be based on the dimension as shown on plan or as otherwise directed or authorized by the Engineer. No measurement shall be made for unauthorized areas or for extra thickness.

The quantity of asphaltic material used is included in the asphalt concrete mixture and will not be measured separately.

Quantities of liquid asphalt, wasted or remaining on hand after completion of the work, shall not be measured or paid for.

203.4.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items listed below and shown in the Bill of Quantities, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item. Asphalt additive or antistripping agent, if allowed and used to meet with JMF requirement shall not be paid directly, payment shall be deemed to be included in the respective pay items of Asphaltic Base Course.

Pay Item No.	Description	Unit of Measurement
203a	Asphaltic Base Course-Plant Mix (Class A)	CM
203b	Asphaltic Base Course-Plant Mix (Class B)	CM
203c	Asphaltic Leveling Course-Plant Mix (Class A)	CM
203d	Asphaltic Leveling Course-Plant Mix (Class B)	CM

TEM 204 SOIL CEMENT STABILIZED SUBBASE AND BASE

204.1 DESCRIPTION

The work shall consist of performing all operations in connection with the construction of cement stabilized subbase or base and all incidentals in accordance with the specifications in conformity with the lines, grade, thickness and typical cross-sections shown on the plans or as directed by the Engineer.

204.2 MATERIAL REQUIREMENTS

204.2.1 Mineral Aggregate

Aggregate shall be clean, tough, hard durable particles free of decomposed stone, organic matter and other deleterious substances and shall consist of material of which at least 50% by weight of the total aggregates shall have at least two (2) mechanically fractured faces for cement stabilized subbase whereas for cement stabilized base course, material shall have at least Ninety (90) percent by weight of total aggregate having two (2) mechanically fractured faces.

Coarse aggregate retained on sieve No. 4 shall have a percentage of wear by Los Angeles Abrasion as determined by AASHTO T 96 not more than forty five (45) for base course and fifty (50) for subbase material.

Fraction Passing 0.075 mm (No. 200) shall not be greater than two-third of the fraction passing the 0.425 mm (No. 40) sieve. The fraction passing 0.425 mm (No. 40) sieve shall have a liquid limit not greater than 25% and plasticity index not greater than 6.

Sandy and gravely soils used for cement stabilization shall fulfill the following grading requirements.

Passing maximum size 50 mm sieve	100%
Passing AASHTO No. 4 sieve	above 50%
Passing AASHTO No. 40 sieve	above 15%
Passing AASHTO No. 200 sieve	below 5%
Clay fraction, finer than 0.002 mm	below 3%

204.2.2 Cement

Cement shall conform in all respect to requirement specified under sub-item 111.2.2 and item 401 "Concrete".

204.2.3 Water

Water used for cement stabilized base course or subbase shall conform in all respect to requirements specified under sub-item 112.2.3.

204.2.4 **Mix Design Requirements in Laboratory**

Prior to commencement the work of stabilization, proposed mix design indicating the exact percentage of cement and water to be used so as to obtain a uniform mixture, shall be submitted by the Contractor for Engineer's approval, and shall fulfill the following requirements:

i) The mixture sample submerged in water for two hours before crushing, after storage in a box having minimum humidity of ninety five (95) percent for Twenty four (24) hours shall have a minimum compressive strength of twenty three (23) kg/sq.cm for sub base and thirty (30) kg/sq. cm for base respectively.

ii) The maximum permissive swelling of volume shall be two (2) percent and maximum loss in weight eight (8) percent when tested in accordance with AASHTO T-135.

iii) Maximum variation during constructions shall be as given below:-

a.	Cement Content:	-1 to +1% of that given in the mix design.
b.	Water contents:	0 to +2% of that given in the mix design.

iv) Bituminous material for curing seal shall be any one of the following :

Type	Applicable Specifications
RC-250	AASHTO M-81
MC-250	AASHTO M-82
SS-1	AASHTO M-140
RT-5	AASHTO M-52

Optimum moisture content shall be determined in accordance with AASHTO T-134 by placing moist sample under shade for seven days and crushing after two hours of immersion in water.

204.2.5 **Composition of Mixture at Site**

The granular material shall thoroughly be mixed at site with sufficient cement to obtain required crushing strength. The cement content shall be determined at the laboratory so that minimum compressive strength of mixture is fifty (50) kg/sq. cm for sub base and eighty (80) kg/sq. cm for base respectively at seven (7) days. The moisture content of the mix cement stabilized material shall not be less than the optimum as determined by AASHTO T-134 Method and nor more than two (2) percent above the optimum as determined by this test or such higher value as may be agreed by the Engineer on basis of preliminary trial.

204.3 CONSTRUCTION REQUIREMENTS

204.3.1 Stationary Plant Method

Equipment, tools, machines used in the performance of cement stabilized subbase, base shall be subject to the approval of Engineer and shall be maintained in satisfactory working condition at all times.

If stationary plant is used, it shall be of the power driven paddle or pan type and may be of batch or continuous type.

If batch mixer is used, measured amount of material and cement shall first be placed in mixer, water being added to bring moisture content of mixture within the optimum range. Mixing shall be continued until mixture is uniformly mixed but in no case less than one minute mixing time.

The mixing plant shall be of approved type, coordinated and operated as to produce mixture within mix design requirements and shall be of sufficient capacity.

The aggregate, cement and water shall be mixed at an approved central mixing plant by either continuous-flow or batch type mixer revolving blades or rotary drum mixer.

The plant shall be equipped with feeding and metering devices that add the materials; cement and water into the mixer in specified quantities; mixed thoroughly and sufficiently to obtain intimate and uniform mixture with out cement lumps.

The mixture shall be transported to paving area in trucks or other approved equipments having clean bed within a maximum hauling time of forty five (45) minutes.

The mixture shall be placed on moist subgrade/or subbase without segregation at a rate that will produce a uniformly compacted layer conforming to the required grade and cross-section. The mixture shall be spread by spreader within thirty minutes after placement of mixture.

Compaction shall start as soon as possible after spreading and elapsed time between the addition of water to mixture and start of compaction shall not exceed ninety (90) minutes.

204.3.2 Mix in Place Method

Cement stabilized subbase/base course can also be constructed by MIX-IN-PLACE method. The plant used for pulverising and mixing the stabilized material shall be approved by the Engineer on the basis of trial conducted to establish that the plant is capable of producing the degree of mixing and uniformity of material according to specification requirement. The material shall be processed throughout the depth of layer with blades of approved mixing equipment. The cement shall be spread ahead of mixer by means of cement spreader, fitted with a device to ensure uniform and required rate of spread of cement both transversely and longitudinally.

Moisture content of the material shall be adjusted to optimum using water sprayer of such design that water is discharged in uniform and controllable manner both transversely and longitudinally.

204.3.3 **Construction Joints**

In the end of each day construction, a straight transverse construction joint shall be formed by cutting into completed work to form a true vertical face.

For large area, a series of parallel lanes of convenient length and width meeting approval of Engineer shall be built with true vertical face free of loose or shattered material.

Guide stakes shall be set for cement spreading and mixing.

Grade and alignment stakes shall be furnished, set and maintained by contractor, in order that the work shall conform to the lines, grade and cross-sections shown on the drawing.

All material shall be placed and spread evenly by mechanical spreader capable of leveling off the material to an even depth. The mixture shall be mixed uniformly with proper moisture content. Areas of segregated material shall be corrected by removing and replacing with satisfactory material or by re-mixing. When necessary to meet the requirements, additional approved material shall be spread in such amounts as are found to be necessary and the added material shall be uniformly mixed into previously placed material, adding water as required to obtain the specified density.

204.3.4 **Compaction**

The thickness of layer shall be as shown on the Drawings but in no case shall be less than eight (8) centimeters. If thickness of each layer does not exceed twenty centimeters, it shall be constructed as one layer. If thickness of layer exceeds twenty (20) centimeters, it shall be constructed in two or more layers each within the range of eight (8) to twenty (20) centimeters in compacted thickness.

The mixture shall be spread and finished true to crown and grade by machine or hand method where machine methods are impracticable as determined by the Engineer and shall be thoroughly compacted with approved rollers until entire depth and width of subbase/base is uniformly compacted to maximum density of 95% as tested according to procedure outlined in AASHTO T-134.

The compaction shall be complete as soon as possible after mixing, normally within three (3) hours after adding water depending on setting time of cement and the weather conditions.

Compaction shall not take place after cement hydration and any material that has been mixed or deposited after cement has hydrated shall be removed and replaced with fresh mix material.

204.3.5 **Preliminary Trial**

At least one (1) week before main work of stabilization is started contractor shall construct a trial section of two hundred (200) meters in length at location approved by the Engineer with same material, equipment, mix proportion and construction procedure that he proposes to use for the main work.

Purpose of this trial section is to determine efficiency of mixing, spreading, compaction, suitability of construction procedures, depth of layer being compacted with available compactive effort.

In place density determination will be made using AASHTO T-191 or AASHTO T-205 & T-238 Method.

204.3.6 **Curing/Maintenance**

After compaction the stabilized subbase/base layer shall be protected against drying out by keeping it continuously damp for a period of at least three (3) days or by coating with approved curing material at the rate approved by the Engineer.

The completed cement stabilized subbase/base shall be maintained in an acceptable condition at all the times, prior to construction of subsequent asphaltic layer.

No vehicular traffic shall be allowed to pass on the compacted layer until curing period has elapsed with a minimum no-traffic period of seven (7) days.

Cement stabilized subbase/base shall be constructed only when the atmospheric temperature is above 4 degrees centigrade and when the weather is not rainy.

204.3.7 **Tolerance**

The surface of each subbase/base course shall be properly shaped to a smooth uniform surface parallel to the finished surface of the carriageway and shall not vary more than the limits as specified in the relevant, "Table for Allowable Tolerances" in these specifications.

The completed Subbase/Base course shall be tested for required thickness and surface before acceptance. Any area having compacted thickness less than the thickness shown in the bill of quantities and/or on the drawings shall be rectified by scarifying the top seventy five (75) mm. reshaping with added material and recompacting all to specification. Skin patching of an area without scarifying the surface to permit proper bonding of added material will not be permitted.

204.4 MEASUREMENT AND PAYMENT

204.4.1 Measurement

The unit of measurement for payment shall be cubic meter of the compacted and accepted subbase/base material as measured in place. Measurement shall not include any areas in excess of that shown on the drawings except the areas authorized, in writing, by the Engineer.

Measurement of cement content used shall be the number of metric Ton consumed to stabilize subbase/base. This quantity of cement used shall not exceed the theoretical percentage established in the laboratory.

Bituminous curing material shall be measured by the metric Ton. The contractor shall furnish in duplicate certified weight tickets from the batch scales of commercial plants.

204.4.2 Payment

Measured quantity of stabilized subbase/base determined as provided above shall be paid for at the contract unit price per cubic meter for a particular item listed below and shown on the Bill of Quantities, which payment shall be full compensation for furnishing all labour, material, tool, plant, equipment, handling, mixing, manipulating, placing, shaping, compacting including necessary water for compaction, rolling, finishing; correcting unsuitable area and unsatisfactory material; maintenance including protection of stabilized subbase/base layer and incidentals necessary for completion of work except cement consumed which shall be paid separately as measured above. Payment for bituminous curing material shall include all labour, material, heating (if required) equipment, spreading and protection from traffic as directed by the Engineer.

Pay Item No.	Description	Unit of Measurement
204a	Cement Stabilized Subbase	CM
204b	Cement Stabilized Base	CM
204c	Cement content	Ton
204d	Liquid Asphalt for curing seal, type ___	Ton
204e	Emulsified Asphalt for curing seal, type ___	Ton

ITEM 205 CRACK - RELIEF LAYER

205.1 DESCRIPTION

The work shall consist of constructing a layer of graded crushed aggregate or asphaltic open-graded plant mix on a prepared soil-cement base course in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings.

205.2 MATERIAL REQUIREMENTS

205.2.1 Aggregates

Material for graded crushed aggregates shall in all respects conform with the requirements specified under Item 202, with the following exceptions and supplementary requirements:

a) The portion of the aggregate retained on the 9.5 mm. (3/8 inch) sieve shall not contain more than 10 percent by weight of flat and/or elongated particles (ratio of maximum to minimum dimension = 2.5:1).

b) Crushed aggregates shall consist of particles with not less than Ninety (90) percent of the portion retained on the 4.75 mm. (No. 4) sieve having at least two fractured faces.

Aggregates for the asphaltic open-graded plant mix shall conform to the requirements of Item 203.2.1 with the following exceptions:

a) Fine aggregates and mineral filler will be required.

b) Sand equivalent and plasticity requirements are not applicable.

205.2.2 Asphaltic Material

Asphaltic binder shall be asphalt cement, 60-70 penetration grade, meeting the requirements of AASHTO M-20.

205.2.3 Asphaltic Open-Graded Mixture

The composition of the asphaltic open-graded crack-relief layer shall meet the following criteria:

Aggregate Grading Requirements		
Sieve Designation mm	Inch	Percent Passing by weight
50	2	100
37.5	1.1/2	75-90
19	3/4	50-70
4.75	No. 4	8-20
0.15	No. 100	0-5
Asphalt Cement Content of total Mix		2-3% by weight
Mixing Time		30 seconds (Maximum)
Mix Design		Within Master Range Gradation

The exact percentage of asphalt cement content shall be such that at least Ninety five (95) percent coating of aggregates will be achieved when tested in accordance with AASHTO T-195.

205.3 CONSTRUCTION REQUIREMENTS

Prior to construction of the crack-relief layer (CRL) the completed soil-cement base course shall be duly accepted by the Engineer.

205.3.1 Graded Crushed Aggregate

Construction of this layer shall conform in all respects to the requirements specified under Item 202.3.

205.3.2 Asphaltic Open-Graded CRL

Construction of this layer shall conform in all respects to the requirements specified under Item 203.3, except as provided below:-

a) Compaction shall be accomplished by ten (10) Ton steel Wheeled tandem rollers. A maximum of three complete coverages, or as otherwise directed by the Engineer, shall be sufficient. No density test will be required, however the compaction shall be achieved in the same manner as displayed in the total test and to satisfaction of the Engineer.

b) The consistency and temperature of the mix shall be such controlled that it does not squeeze out or move under the pressure of compacting roller. For this purpose, trial reaches shall be prepared by the contractor to fix the above parameters.

In order to ensure the stability of CRL before the placement of any subsequent layer or opening of a layer to traffic, a priming time of 4 days in hot weather will be allowed. This tine may be reduced to two days where the lower temperature allows.

c) All traffic shall be kept off this layer until a subsequent layer has been placed on it. Any damage caused by traffic moving directly on the crack-relief layer shall be the responsibility of the Contractor and all necessary repair work thereto shall be at the Contractor's expense.

205.4 MEASUREMENT AND PAYMENT

205.4.1 Measurement

The quantity of graded crushed aggregate crack-relief asphaltic open graded layer to be paid for shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed graded crushed aggregate crack-relief layer.

The quantity of asphaltic open graded crack relief layer shall be measured in cubic meters by taking out cores as detailed for Base Course Asphalt under item 203.4.1

The quantity of Asphaltic material is included in the mixture and will not be measured separately.

205.4.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items listed below and shown in the Bill of Quantities. which prices and payment shall constitute full compensation for all costs necessary for the proper completion of the work prescribed in this item:

Pay Item No.	Description	Unit of Measurement
205a	Graded Crushed Aggregate Crack-Relief Layer	CM
205b	Asphaltic Open-Graded Plant Mix Crack Relief Layer	CM

ITEM 206 WATER BOUND MACADAM BASE

206.1 DESCRIPTION

This work shall consist of furnishing and placing one or more courses of clean crushed stone base mechanically interlocked by rolling, and voids thereof filled with screening and binding material with the assistance of water, laid on a prepared subgrade, sub base, or existing pavement in conformity with the lines, grades and cross-sections shown on the drawings.

Unless otherwise directed by the Engineer this item of work may be applied to road structure or shoulders.

206.2 MATERIAL REQUIREMENTS

Coarse aggregates either crushed or broken stone shall conform to the quality requirements as specified hereunder, except that no CBR testing will be required. The gradation curve of the coarse aggregate shall be within the envelop limits given below:-

Sieve Designation		Percent Passing by weight		
mm	Inch	Class A	Class B	Class C
102	(4")	100		
89	(3.1/2:)	90 - 100		
76	(3")	–	100	
63.5	(2.1/2")	25 - 60	90 - 100	100
50	(2")	–	25 - 75	90 - 100
37.5	(1.1/2")	0 - 15	0 - 15	35 - 70.
25	(1")	–	–	0 - 15
19	(3/4")	0 - 5	0 - 5	0 - 5
12.5	(1/2")	–	–	–

Fine aggregate (filler material or screenings) shall consist of crushed stone screenings or any other fine material approved by the Engineer. It shall be free from clay lumps, dirt and other objectionable material. The fine aggregate shall be of the following gradation.

Sieve Designation mm	Inch	Percent Passing by weight
9.5	3/8	100
4.35	No. 4	85-100
0.15	No. 100	10-30

The material passing No. 40 sieve shall have a liquid Limit of not more than twenty five (25) and a Plasticity Index of not more than six (6).

206.2.1 **Physical Requirements**

The additional physical requirements of coarse aggregates for water bound macadam will satisfy the following limits:-

a. Loss Angeles Abrasion Value Max 45%
b. Flakiness Index Max 15%
c. The loss when subject to five cycles of the Sodium Sulphate Soundness test (AASHTO T-104) shall be less than twelve (12).

206.2.2 **Binding Material**

Binding material to prevent raveling of water bound macadam shall consist of a fine grained material passing 100 percent through 425 micron sieve and possessing P.I value of four to nine (4-9) when the Water Bound Macadam (WBM) is to be used as a surfacing course, and upto 6 when WBM is being adopted as sub-base/base course with bituminous surfacing. If lime stone formations are available nearby, lime stones dust or as directed by the Engineer, may be used fully employed for this purpose.

206.3 **CONSTRUCTION REQUIREMENTS**

206.3.1 **Equipment**

Any combination of machines or equipment that will produce the results meeting these specifications may be used with the approval of the Engineer. These include mechanical spreaders, water sprinklers and rollers/compactors.

206.3.2 **Structure Preparation**

Preparation of surface for water bound macadam, shall be carried out in the same manner as for aggregate base course item 202.3.1.

Where the existing road surface is black topped, 50 mm x 50 mm furrows shall be cut in the existing surface at one (1) meter intervals at forty five (45) degree to the centre line of the carriage-way before proceeding with the laying of coarse aggregates.

Before starting with WBM Construction, necessary arrangements shall be made for the lateral confinement of aggregates. One method is to construct side shoulders in advance to a thickness corresponding to the compacted layer of the WBM course. After shoulders are ready, there inside edges may be trimmed vertical and the included area cleaned of all spilled material thereby setting the stage for spread of coarse aggregates. The practice of constructing WBM in a trench section excavated in the finished formation must be avoided.

206.3.3 **Spreading and Compaction**

Crushed stone shall be deposited and spread on the prepared surface to the proper depth so that the compacted layer will not exceed two and a half (2.1/2) times the thickness of maximum aggregate size. Each layer shall be inspected thoroughly before rolling to detect high or low spots. Crushed stones shall be added or shifted to provide a true surface. The course aggregate layer, after being laid to proper thickness, shall be lightly rolled sufficient only to establish the required grade and level of the stones.

Spreading of the coarse aggregates shall be followed by rolling with a smooth wheel roller weighing at least 10 tons. Rolling shall begin at the lower edge of the shoulders to lock the stones firmly at the edge, then progress gradually towards the centre line. Rolling shall continue until the aggregate is well keyed and does not creep ahead of the roller.

In no case, shall coarse aggregates be stored in heaps directly on the area where these are to be laid nor shall the hauling over a partly completed base be permitted, however dumpers shall be allowed at the construction area where the material will be spreaded quickly after dumping.

Following the initial rolling, dry screenings shall be applied uniformly over the surface. Dry rolling shall be continued while screenings are being applied. The surface shall be swept with mechanical or hand brooms to aid spreading of the screenings.

When the interstices in the coarse aggregate are filled with screenings, the surface shall be sprinkled with water until it is saturated. The rolling, sprinkling and application of additional screenings shall continue until a grout is formed that fills all the voids and forms a wave of grout in front of the roller.

When more than one layer is required to complete the Macadam base course to the thickness shown on the drawings, each layer shall be constructed as before prescribed.

206.3.4 **Construction Control Testing**

Tests for compliance with the requirements of Item 206.2 will be made as often as deemed necessary and to the satisfaction of the Engineer.

206.3.5 **Maintenance**

The completed base course shall be maintained in an acceptable condition until the necessary subsequent treatment is applied.

206.4 MEASUREMENT AND PAYMENT

206.4.1 Measurement

The quantity of Water Bound Macadam Base to be paid for shall be measured by the theoretical volume in place, as shown on the Drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed Waterbound Macadam Base Course. No allowance will be given for materials placed outside the theoretical limits shown on the cross-sections.

206.4.2 Payment

The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of Water Bound Macadam Base, for the pay items listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
206a	Water Bound Macadam Base with Coarse Agg: Class A	CM
206b	Water Bound Macadam Base with Coarse Agg: Class B	CM
206c	Water Bound Macadam Base with Coarse Agg: Class C	CM

ITEM 207 DEEP PATCHING

207.1 DESCRIPTION

This work shall be carried out in patches of roads where the existing road base material has moved and is lying in loose condition. Requirement under this item is to remove the existing road base and to strengthen it to take new layer of aggregate or water bound macadam base.

207.2 MATERIAL REQUIREMENTS

Fresh aggregate base or water bound macadam base may be required to be added to existing road base. Specification for such material shall conform to material requirements of item 202.2 or 206.2.

207.3 CONSTRUCTION REQUIREMENTS

Patches of roads in which surface courses have broken and road base has moved, the material which has lost its compaction shall be removed. Next layer shall be watered and compacted, thereby the removed material shall be placed back duly screened to remove plastic contamination, by hand picking and passing though sieve No. 4. after properly watering and mixing. Material will be recompacted in layers not exceeding fifteen (15) cms thick with approved equipments. Additional material will be added, if needed particularly non-plastic fines passing sieve No. 4.

207.4 MEASUREMENT AND PAYMENT

207.4.1 Measurement

The quantity of deep patching to be paid for shall be measured in square meter of the area demarcated or approved by the Engineer. The minimum area will be taken as 0.5 square meters irrespective of the size of the pot hole.

207.4.2 Payment

The accepted quantities measured as provided above shall be paid for at the contract unit price per square meter of deep patching, which price payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete the item:

Pay Item No.	Description	Unit of Measurement
207a	Deep Patching (0-15 cm)	SM
207b	Deep Patching (15-30 cm)	SM

ITEM 208 REINSTATEMENT OF ROAD SURFACE

208.1 DESCRIPTION

This work shall consist of reinstatement of worn out road surface with a material approved by the Engineer. Pot holes, ditches and depressions shall be filled with the approved materials in layers in conformity with lines, grades, sections and dimensions, as directed by the Engineer.

208.2 MATERIAL REQUIREMENTS

The material used under this item shall conform to the material requirement of different B.O.Q. items selected for use by the Engineer.

208.3 CONSTRUCTION REQUIREMENTS

The contractor shall remove loose material from the pot holes or from road depressions and shall also reshape the holes and depression by removing firm material as directed by the Engineer and dispose all material according to the instruction of the Engineer. The surface thus exposed shall be compacted in accordance with applicable requirement, for reinstatement of surface the Engineer shall select item of work as mentioned here under:

1) Granular subbase.
2) Aggregate base course.
3) Water bound macadam.
4) Asphalt base course.
5) Surface treatment.

The Engineer may select one, or more than one of the items mentioned above to reinstate the pot hole or depressions in the road surface according to size and depth of the hole or depression.

208.4 MEASUREMENT AND PAYMENT

208.4.1 Measurement

The quantities to be paid for shall be the number of square meter of pot holes or road depressions, reinstated in accordance with the requirement of this item.

The material used for reinstatement of the pot hole or road depression shall be measured in cubic meter or tones as applicable under the item used.

208.4.2 **Payment**

The accepted quantities measured, as provided above shall be paid for at the contract unit price per square meter of reinstated surface, as for the pay item listed below and as shown on the bill of quantities which price shall constitute full compensation for excavation and disposal of material, watering, rolling, labour, equipment, tools, and incidental necessary to complete this item.

However the material used such as subbase, aggregate base course, water bound Macadam or asphaltic base course shall be paid at the rates applicable to the item.

Pay Item No.	Description	Unit of Measurement
208	Reinstatement of Road Surface	SM

ITEM 209 SCARIFICATION OF EXISTING ROAD/BREAKING OF ROAD PAVEMENT STRUCTURE

209.1 DESCRIPTION

This item shall consist of scarification of existing road surface or breaking of existing road pavement structure to ensure bondage of new layer with the existing road pavement and to ensure drainage of water below the surface of freshly laid aggregate base. The surface on which the base material is to be constructed shall be approved and accepted by the Engineer prior to placing the crushed stone base aggregate.

209.2 CONSTRUCTION REQUIREMENTS

The method of scarification of road surface or breaking of pavement structure shall be proposed by the contractor and approved by the Engineer, in accordance with the requirements under site conditions.

After the existing pavement structure has been broken off, the material shall be removed and disposed off outside the right of way, according to the satisfaction of the Engineer. The surface obtained after scarification or breaking the existing pavement shall be compacted to the density prescribed under item 108.3.1. Payment of such compaction shall be included in the contract price for item 209.

209.3 MEASUREMENT AND PAYMENT

209.3.1 Measurement

The quantity for road pavement structure broken and removed, to be paid for shall be measurement in Cu. meter to a depth as shown in the drawings/cross sections or as specified by the Engineer and in the area earmarked by the Engineer for such purpose.

The quantity for road pavement structure scarified, to be paid for shall be measured in Sq. meter as shown in the drawings/cross sections or as specified by the Engineer and in the area earmarked by the Engineer for such purpose

209.3.2 Payment

The quantities as measured above shall be paid for at the contract unit price per Cu. meter of breaking of road pavement structure and per Sq. meter of scarification of existing road pavement structure, for carrying out the works mentioned above including cost of labour, equipment, tools and incidental necessary to complete these items.

Pay Item No.	Description	Unit of Measurement
209a	Breaking of Existing Road Pavement Structure	CM
209b	Scarification of Existing Road Pavement	SM

ITEM 210 PAVEMENT WIDENING

210.1 DESCRIPTION

This work shall consist of the widening of the existing pavement and finishing of the completed work in accordance with the specifications and in conformity with the lines, grades, thickness of each pavement component and typical cross-sections shown on the plans or as directed by the Engineer.

210.2 MATERIALS

Materials for the construction of "Pavement Widening" shall conform to the requirements specified in relevant items of Subbase and Base course in these specifications.

210.3 TRENCHING

The contractor shall excavate along the edge of the existing pavement for the full depth and width as indicated on the Drawings or as directed by the Engineer. The bottom of the trench shall be compacted with rollers and/or tampers approved by the Engineer to minimum ninety five (95) % of the maximum dry density as per AASHTO T-191 method. If the plans do not call for a specific type of compaction, the subgrade, subbase or base shall be compacted by rolling with an approved type trench roller until the entire surface is smooth, firm and at the designated elevation. Adequate provisions shall be made for drainage of the trench to prevent damage to the subgrade. Prior to placing any widening material, the trench shall be cleaned of all loose material. The edge of the existing pavement shall be thoroughly cleaned. The trench must be approved by the Engineer, before placing any widening material. All subsequent layers shall be compacted to the degree as shown under relevant item of these specifications

210.4 SPECIAL PROVISIONS FOR HANDLING TRAFFIC

Widening operations shall be permitted on only one (1) side of the pavement at a time and excavation of trenches shall be permitted only sufficiently in advance of other operations to ensure a continuity of the operations of excavating, placing widening material, and rolling.

Reflectorized barricades shall be placed along open trenches day and night. Lighting shall be placed at each barricade at night. Barricades and lights shall be approved by the Engineer. The barricades shall be placed at intervals not to exceed one hundred (100) meters or as directed by the Engineer.

The Contractor shall make adequate provision to enable traffic to cross open trenches at intersecting roads, streets and private entrances.

Partial shouldering shall be performed immediately after completion of widening of portions of the Work in order to eliminate the hazard.

No separate payment will be made for handling traffic which will be considered subsidiary to the item of "Pavement Widening."

210.5 MEASUREMENT AND PAYMENT

210.5.1 Measurement

"Pavement Widening" shall be measured by the unit of cubic meter and shall include all excavation, trimming, disposal and compaction of subgrade and subsequent layers of subbase and base course.

The removal of edge kerb if exists, will not be paid for separately but will be considered subsidiary to the item of "Pavement Widening".

Water, ordered by the Engineer or added with the consent of the Engineer, which is necessary to obtain satisfactory compaction of the foundation treatment will not be paid for separately, but will be considered subsidiary to the item of "Pavement Widening". No measurement will be made of unauthorized areas or for extra width or thickness.

210.5.2 Payment

The amount of completed and accepted Work, measured as provided above, will be paid for at the unit price bid in the Bill of Quantities for "Pavement Widening," which price shall be full compensation for furnishing materials, such as subbase, base course and water etc., for all labour, equipment, tools, supplies, and all other items necessary for the proper completion of the Work.

Pay Item No.	Description	Unit of Measurement
210	Pavement Widening	CM

ITEM 211 LIME STABILIZED AGGREGATE BASE COURSE

211.1 DESCRIPTION

This work shall consist of performing all operations in connection with construction of "Lime Stabilized Aggregate Base Course" on the prepared Subbase or Subgrade surface and all incidentals in accordance with the specifications in conformity with the lines and level grade, and typical cross-sections shown on the plans.

211.2 MATERIAL REQUIREMENTS

211.2.1 Coarse Aggregate

Coarse Aggregates for crushed Lime stabilized Base Course shall be composed of hard, tough, sound durable crushed limestone, particles free from thin and elongated, soft and disintegrated material or other objectionable matters, complying with the following requirements.

Table 211/2

CRUSHED STONE GRADING

Sieve Designation mm	Sieve Designation Inch	Percent Passing by Weight
37.5	1.1/2	100
25.0	1	80-100
12.5	1/2	50-80
4.75	No. 4	30-60
0.425	No. 40	10-30
0.075	No. 200	5-15

The fraction of material passing 0.075 mm (No. 200 Sieve) shall not be more than 60% the fraction passing 0.425 mm (No. 40 Sieve).

Crushing of boulder or rock shall be regulated in such a way that fraction of aggregates retained No. 40 (0.425 mm) sieve shall contain at least Ninety (90) percent by weight of crushed particles having more than one mechanical fractured faces.

The Abrasion loss of Crushed Lime Stone as determined by AASHTO T96-74 shall not exceed forty five (45) percent.

211.2.2 Fine Aggregate

The fraction of crushed aggregates passing No. 4 sieve shall consist of stone screenings free of loam, organic or other matter.

The material passing 0.425 mm (No. 40) sieve when prepared in accordance with AASHTO T 146-49 and tested by appropriate methods shall conform with the following requirement.

Liquid Limit	25% Maximum.
Plasticity Index	6 Maximum.

The calcium sulphate content of the fraction retained on sieve No. 4 shall not exceed ten (10) percent by weight.

211.3 CONSTRUCTION REQUIREMENTS

211.3.1 Equipment

All equipment, tools and machines used in the performance of the work shall be in good working condition and maintained all the times.

Blade graders, if used for spreading, the material shall have adjustable blades for slopes.

All sprinkling equipment shall be suitable for applying water uniformly and at controlled quantities to variable width of surface.

Transport vehicles carrying plant mix material shall have a capacity suited to the output of mixing plant and the site condition.

Mixing plant shall be of approved type, coordinated and operated so as to produce a mixture within required specification limit and shall have sufficient capacity.

211.3.2 Construction

Grade and alignment control stakes shall be furnished, set and maintained by the contractor in order that work shall conform to the lines, grade and cross-section shown on the drawings.

Material shall be placed and spread evenly using mechanical spreader. The spreader shall be adjustable so that width and thickness of the spreader can be set to any dimension required by the drawings and for uniform and complete coverage.

Aggregate shall be spread to loose thickness necessary to obtain the required compacted thickness of the layer.

Immediately after spreading and shaping operation, the mixture shall be thoroughly compacted with approved rollers. Water shall be applied to the materials during the rolling operation in such amount as may be required to obtain the specified density. In all the places not accessible to the rolling equipment, the material shall be compacted thoroughly with approved mechanical or hand tampers to density comparable to that obtained by

rolling. The surface of the final layer shall be finished by blading and the addition of water, until the surface is smooth and free from waves and irregularities and is true to grade and cross-section. Where the thickness exceeds twelve and half (12.5) centimeters, it shall be compacted in two layers of equal thickness except that if vibratory roller is used for compaction, the layer thickness may be increased to maximum of twenty five (25) centimeters provided that satisfactory compaction is achieved.

Each layer shall be compacted until the entire depth of course is at least 95% of density at optimum moisture content as determined by AASHTO T 180-74. Compaction shall be completed as soon as possible after the material has been spread.

211.3.3 Thickness and Finish

Completed base course shall be tested for the required thickness and smoothness before acceptance. Any areas of the completed base course having compacted thickness less than the thickness shown on the drawing, or waves and irregularities as specified in the relevant, "Table for Allowable Tolerances", in these specifications shall be corrected by scarifying the surface, adding approved material, reshaping, recompacting and finishing as specified and as approved by the Engineer. Skin patching of an area without scarifying the surface to permit proper bonding of added material will not be permitted.

211.3.4 Maintenance

The completed base course shall be maintained in an acceptable condition at all times until prime coat is applied. When the base course is to carry traffic for an indefinite length of time before receiving the surfacing or pavement, the contractor shall maintain the surface until final acceptance and shall prevent raveling by wetting, blading, rolling and the addition of fines as may be required to keep the base tightly bound and leave a slight excess of material over the entire surface, which must be removed and the finish restored before the application of prime coat.

211.4 MEASUREMENT AND PAYMENT

211.4.1 Measurement

The unit of measurement for payment shall be in cubic meter of the completed and accepted crushed lime stone base course as measured in place. Measurement shall not include any area in excess of that shown on the drawings except the area authorized in writing by the Engineer. Measurement of lime used shall be the number of metric Ton consumed to stabilize base course. This quantity of lime used shall not exceed the theoretical percentage established in the laboratory.

211.4.2 **Payment**

Measured quantities of crushed limestone base course determined as above shall be paid for at the contract unit price per cubic meter for particular item listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing all labour, material, tool, plant, equipment; handling, mixing, manipulating, placing, shaping, compacting including necessary water for compaction, rolling, finishing; correcting unsuitable areas and unsatisfactory material; maintenance including protection of prepared base course and all incidentals necessary for completion of work except lime used which shall be paid separately as measured above.

Pay Item No.	Description	Unit of Measurement
211a	Lime Stabilized Aggregate Base Course	CM.
211b	Lime	Ton.

ITEM 212 BITUMEN STABILIZED SUB-BASE OR BASE

212.1 DESCRIPTION

This work shall consist of performing all operation in connection with construction of bitumen stabilized subbase or base and all incidentals in conformity with the lines and level, grade, thickness and typical cross-section shown on the drawings or as directed by the Engineer.

212.2 MATERIAL REQUIREMENTS

If stationary plant is used for blending, all ingredients shall comply with any of the grading curve given in Table 1 whereas for mix in place method, in situ sand and gravel shall meet the gradation requirement as per Table 2 for bitumen stabilized Subbase or Base Course.

Coarse aggregate retained on 4.75 mm (No. 4) sieve shall consist of tough, hard and durable particles free from decomposed stone, organic matter and other deleterious substances.

Crushing of material shall be regulated such that material retained on 4.75mm (NO. 4) sieve shall have 50% by weight of total aggregates with at least two (2) mechanically fractured faces in case of bitumen stabilized subbase where as for bitumen stabilized base, material retained on No. 4 sieve shall have at least Ninety (90) percent by weight of total aggregate with two (2) mechanically fractured faces.

Aggregate retained on sieve No. 4 shall have a percentage of wear by Los Angles Abrasion Test as determined by AASHTO T-96 not more than forty five (45) percent in case of base course material and fifty (50) percent in case of sub-base material.

Fraction passing 0.075mm (No. 200) sieve shall not be greater than 2/3 rd of the fraction passing the 0.425mm (No. 40) sieve. The fraction passing 0.425 mm (No. 40) shall have a liquid limit not greater than 25% and plasticity Index not greater that 6.

If mineral aggregates contain moisture thus necessitating drying, bitumen material shall be of such nature that it will not foam when heated to hundred and eighty (180) degree centigrade and shall conform with requirements as shown in Table 301.2.

In dry areas, where natural moisture content of mineral aggregate is low bitumen binder shall be cut back conforming with the following requirements. Cut back shall meet the requirement of AASHTO M 81-70 and M 82-73 for rapid and medium curing type respectively . It shall comply with the requirements of AASHTO T 49-74, T 50-69, T 78-74 for the selected grade to suit the cutback as approved by the Engineer. Alternatively the bituminous binder shall be asphaltic cement of 80/100 penetration in summer and 120/150 in winter; bitumen emulsion of 80/100 penetration in summer and 150/180 penetration in winter. The bituminous emulsion shall comply with the requirements of AASHTO M 100-70 and be tested in accordance with AASHTO T 59-74.

Bitumen-Aggregate mixture for the grade of bitumen selected shall be ascertained by trial mixes using Marshal Method to determine the amount by weight of dry material, and using either heated or unheated aggregates as appropriate.

TENTATIVE CRITERIA FOR BITUMEN-AGGREGATE SUBBASE / BASE MATERIAL

Characteristic	Subbase	Base
Marshal Stability (Min)	250 Kg	400 Kg
Flow (Min)	2 mm	2 mm

TABLE - 1

SELECTED GRANULAR SUBBASE /BASE MATERIAL-GRADING.

Sieve Designation		Percent Passing by weight		
mm	Inch	Type-A	Type-B	Type-C
75	3 inch.	100	—	—
50	2 inch.	90 -100	100	—
25	1 inch.	55 - 90	70-100	100
9.5	1/8 inch.	35 - 65	50-80	65-95
4.75	No. 4	25 - 55	40-65	50-80
2.0	No. 10	20 - 40	30-50	40-65
0.425	No. 40	10 - 25	15-25	20-35
0.075	No. 200	3 - 10	3-10	3-10

Table - 2

SAND - GRAVEL SUB BASE MATERIAL - GRADING

Sieve Designation		
mm	Inch	Percent Passing by Weight
37.5	1.1/2 Inch.	100
25.0	1 Inch.	80-100
12.5	1/2 Inch.	50-80
4.75	No. 4	30-60
0.425	No. 40	10-30
0.075	No. 200	5-15

Fine aggregate passing 4.75 mm (No. 4 Sieve) shall consist of sharp natural sand, free from organic or other objectionable substances.

212.3 CONSTRUCTION REQUIREMENTS

All equipment, tools, machines used in the performance of work shall be in good working condition and be subject to the approval of the Engineer, and shall be maintained in satisfactory working condition at all times.

Blade grader if used shall have an adjustable blade for slopes and shall be self propelled.

212.3.1 Mix in Place Method of Construction

Mix in place method of construction may be adopted where the use of low viscosity binder i.e. Cutback or Bitumen emulsion are found suitable.

Grade and alignment control stakes shall be furnished, set and maintained by the contractor in order that work shall conform to the line, grade and cross-section shown on the drawings. The stakes shall be set in rows on and parallel to the center line of pavement and spaced so that string line may be stretched between them.

All material shall be placed evenly using mechanical spreader or spreader box operated with a mechanism which levels off the surface to an even depth.

Mixing shall be accomplished on one or more passes of the mixer through the material and shall be continued until the resulting mixture is entirely uniform and of proper moisture content. Moisture content, if less than required, shall be adjusted by sprinkling equipment, which shall be suitable for applying water uniformly and at controlled amount to variable depth of layer.

Areas of segregated material shall be corrected by removing and replacing with satisfactory material or by re-mixing. When necessary to meet the requirement of specified, additional approved material shall be spread in such amounts as are found to be necessary and the added material shall be uniformly spread adding water if required to obtain the specified density.

212.3.2 Stationary Mixing Plant Method

Stationary plant method of construction will be used where stabilization with asphalt cement binder of penetration grade 80/100 is necessary.

The mixing plant shall be designed, coordinated and operated so as to produce mixture within required Job-Mix-Formula and shall have sufficient capacity. The plant shall be weigh batch type.

Transport vehicles carrying plant mix material shall have a capacity suited to the output of mixing plant and the site condition and be capable of discharging cleanly. Segregation of material shall be avoided.

212.3.3 **Compaction**

Immediately after spreading, shaping to required level, crown and grade, the mixture shall be thoroughly compacted with rubber or pneumatic tyred rollers. Compaction shall continue until the entire depth and width of Subbase/Base is uniformly compacted. Rolling shall begin at the low side and progress towards the higher side overlapping each preceding trip until entire surface has been rolled. Alternate trip of roller shall be of slightly different length. Roller shall be in good working condition, capable of reversing without back lash and shall be operated by skilled operator.

Compaction shall be checked on stabilized layer in accordance with ASTM-D 915-61 (1973). The bulk density of the mixture shall not be less than ninety eight (98) % of the laboratory bulk density. Deficient pavement shall be removed and replaced with satisfactory material.

212.3.4 **Tolerance**

Tolerance in the compacted layer shall be as specified in the relevant, "Table for Allowable Tolerances" in these specifications.

212.3.5 **Curing and Maintenance**

After compaction, the stabilized Subbase/Base shall be protected against damage and maintained in an acceptable condition at all times prior to the construction of subsequent courses.

No vehicular traffic shall be allowed to pass on the stabilized surface for a minimum period of two (2) days.

212.3.6 **Weather Limitations**

Laying of bitumen stabilized base/subbase shall be avoided when air temp is four degrees centigrade or below or when whether is rainy or foggy. Placing of mixture shall also be avoided when surface is wet or on any surface which is frozen or covered with ice or snow.

212.4 **MEASUREMENT OF PAYMENT**

212.4.1 **Measurement**

The unit of measurement for payment shall be cubic meter for the compacted and accepted bitumen stabilized subbase/base course as measured in place. Measurement shall not include any area except the area authorized in writing by the Engineer. Measurement of bitumen binder used shall be the number of metric Ton used to stabilize sub base or base course. The quantity of bitumen used shall not exceed the theoretical percentage established in the laboratory.

212.4.2 **Payment**

Measured quantity of stabilized Subbase/Base determined as above shall be paid for at the contract unit price per cubic meter for particular items listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing of labour, material, tool, plant, equipment, handling, mixing, manipulating, placing, shaping, compacting, rolling, finishing, correcting unsuitable areas and unsatisfactory material, maintenance including protection of stabilized Subbase/Base and all incidentals necessary for the completion of work except bitumen consumed which shall be paid separately as measured above.

Pay Item No.	Description	Unit of Measurement
212a	Bitumen Stabilized Subbase.	CM
212b	Bitumen Stabilized Base Course.	CM
212c	Bitumen Binder.	Ton

ITEM 213 COLD RECYCLING OF ROAD PAVEMENT STRUCTURE/SOIL STABILIZATION.

213.1 DESCRIPTION

This item shall consist of breaking, removal, mixing, relaying and compaction of layers of surface, base and subbase course in a single operation. In this operation, addition of water or binder will also be required to add strength to the mix.

213.2 MATERIAL REQUIREMENTS

No fresh material is to be used as far as quarry materials are concerned. However in order to achieve proper strength of the relayed material; water, cement or bitumen binder may be required to be added. Specification requirements of these ingredients shall be same as described under relative items of work. Cement and bitumen binder of following nomenclature shall be used.

i) Ordinary Portland cement (Type-I)

ii) Emulsified asphalt (RS-1, RS-2, SS-1, SS-1h)

213.3 CONSTRUCTION REQUIREMENTS

213.3.1 Equipment

Equipment utilized for this item of work shall ensure following activities in a single operation:

i) Breaking of layers in full depth in single operation.

ii) Pulverizing and mixing of different types of materials to give homogeneous mix.

iii) Mixing of water or bitumen binder in the total mass.

iv) Laying of treated material in smooth layer, keeping the grade and line as per design.

213.3.2 Cold Recycling of Asphalt

a. Milling Process

This work shall be carried out by specialized equipment designed to break and pulverize the asphaltic layer in a manner that maximum size of broken material reduces to basic size of aggregates. Asphaltic material lumps shall be reduced to a maximum size of fifteen (15) mm.

b. Additives

Bitumen binder (Emulsified Asphalt) shall be added to the mix through a computerised, electronically controlled unit for selecting and measuring the required amount. Bitumen binder and additives shall be added with pump and spray/injection system. Quantity of bitumen binder shall be controlled by programmable micro processors with respect to forward speed, milling depth, milling width and density of material.

c. Mixing and Laying

Milled materials and additives shall be mixed in a forced mixer to make the mass completely homogeneous. Material thus prepared shall be relayed through paving block having tamping and vibrating paving screeds. Paving screeds should be designed to provide initial compaction and shaping the surface to give the required grade and profile.

d. Compaction

Initial compaction shall be provided with paving screeds, however final compaction shall be carried out with conventional rolling equipment approved by the Engineer considering the type of material and thickness of recycled layer. However final compaction shall be checked after completion of rolling as determined by AASHTO T-230 method and shall not be less than ninety seven (97) percent of the Marshall density.

e. General

Total width of road asphalt shall be recycled in a number of strips, depending on width of recycling equipment and width of road. However all longitudinal and lateral joints shall be properly worked up to ensure smooth riding quality.

213.4 SOIL STABILIZATION

a. Milling Process

This work shall be carried out by specialized equipment designed to break and pulverize asphaltic layers and base and subbase courses to a depth of maximum three hundred (300) mm in a single operation. Breaking and pulverizing shall ensure reduction of binding material to reduce to a size of 50 mm (maximum) or to a smaller size depending on the thickness of relayed layer.

In case cement is to be used for improving the strength of relayed mix, the same shall be calculated and spread over the pavement structure before milling starts.

b. Additives

Water shall be added to the mix through a computerized, electronically controlled unit for selecting and measuring the required amount, water shall be added with pump and spray/injection system. Quantity of water shall be controlled by programmable micro processor with respect to forward speed, milling depth, milling width and density of materials.

c. Mixing and Laying

Milled materials and additives shall be mixed in a forced mixer to make the mass completely homogeneous. Material thus prepared shall be relayed through paving block having tamping and vibrating paving screed. Paving screeds should be designed to provide initial compaction and shaping the surface to give the required grade and profile.

d. Compaction

Initial compaction shall be provided with paving screeds, however final compaction shall be carried out with conventional rolling equipment approved by the Engineer considering the type of material and thickness of recycled layer. However final compaction shall be checked after completion of rolling as determined by AASHTO T-230 method and shall not be less than Ninety Five (95) percent of the modified proctor density.

e. General

Total width of road asphalt shall be recycled in a number of strips, depending on width of recycling equipment and width of road. However all longitudinal and lateral joints shall be properly worked up to ensure smooth riding quality.

213.5 MEASUREMENT AND PAYMENT

213.5.1 Measurement

The quantity of cold recycling or soil stabilization to be paid for shall be measured by the theoretical volume recycled as shown on the drawings or as directed by the Engineer, completed in place as per procedure detailed above. No allowance shall be given to material laid outside approved theoretical limits.

Measurement for bitumen binder shall be made in tons delivered to the equipment for work minus the balance left in the equipment.

Measurement for cement shall be made equal to the number of tons of cement delivered and laid over the pavement in manner described above.

213.5.2 **Payment**

The accepted quantities measured as provided above, shall be paid for at the contract unit price for each of the particular pay item listed below, which price and payment shall constitute full compensation for furnishing all materials, labour, equipments, tools and incidentals to complete the item.

Pay Item No.	Description	Unit of Measurement
213a	Cold recycling of Asphaltic layer	CM
213b	Soil Stabilization	CM
213c	Bitumen Binder (Asphaltic Emulsion)	Ton
213d	Cement Binder (O.P.C - Type-I)	Ton

ITEM 214 ASPHALTIC CONCRETE BINDER COURSE

214.1 DESCRIPTION

This work shall consist of furnishing and mixing aggregates and asphalt binder at a central mixing plant, transporting, spreading and compacting the mixture on a prepared base in accordance with these specifications and to the lines, grades and typical pavement sections shown on the Drawings or as directed by the Engineer.

214.2 MATERIAL REQUIREMENTS.

214.2.1 Aggregates.

Coarse and fine aggregates shall be clean, hard, tough, sound particles free from decomposed material, vegetable matter and other deleterious substances, and be of uniform quality, geology and petrology. Water borne material such as river bed gravel, if used, shall also conform to the above criteria.

Coarse aggregate, which is material retained on the No. 4 sieve, shall consist of crushed rock, crushed gravel or a mixture of natural and crushed gravel. The aggregate shall contain not more than 8% by weight of flats/or elongated particles (ratio maximum to minimum 5:1) and shall contain 100% angular material, such that all faces of each piece are fractured faces in cuboid shape.

Fine aggregate, which is material passing the No. 4 sieve shall consist of 100% crushed material from rock or boulder. No natural sand will be allowed in the mix.

When the combined grading of the coarse and fine aggregates is deficient in material passing the No. 200 sieve, additional filler material shall be added. The filler material shall consist of finely divided rock crust, hydrated lime, hydraulic cement or other suitable mineral matter and shall conform to the following gradation:

US Standard Sieve	Percent Passing by Weight
No. 30	100
No. 50	95-100
No. 200	70-100

The Coarse and fine aggregates shall meet the following requirements:

a) The percentage of wear by the Los Angles Abrasion test (AASHTO T 96) shall not be more than 40%.

b) The loss when subject to five cycles of the Sodium Sulphate Soundness test (AASHTO T 140) shall be less than 12%.

c) The Sand Equivalent (AASHTO T-176) determined after all processing except for addition of asphalt cement should not be less than 45.

d) All aggregates shall have a liquid limit of not more than 25% and a Plasticity Index of not more than 4 as determined by AASHTO T-89 and T-90.

e) The portion of aggregate retained on the 9.5 mm (3/8 inch) sieve shall not contain more than 15 percent by weight of flat and/or elongated particles (ratio of maximum to minimum dimensions = 2.5:1).

214.2.2 **Asphaltic Material**

Asphaltic binder to be mixed with the aggregate to produce asphaltic base shall be as asphalt cement penetration grade 40-50, or 60-70 or 80-100, as specified by the Engineer. Generally it will meet the requirement of AASHTO M-20.

214.2.3 **Asphalt Concrete Binder Course Mixture.**

The composition of the asphaltic concrete paving mixture for binder course shall conform to class shown in the following table:

Table No. 1
Combined Aggregate Grading Requirements

Sieve Designation mm	Inch	Percent Passing by Weight
25	1	100
19	3/4	90-100
9.5	3/8	56-80
4.75	No. 4	35-65
2.38	No. 8	23-49
0.30	No. 50	5-19
0.075	No. 200	2-8

Asphalt Content Weight Percent of total mix.	**3.5 (minimum)**

The asphalt concrete binder course mixture shall meet the following Marshal Test Criteria:

Compaction, number of blows each end of Specimen	75
Stability (Minimum)	1000 Kg.
Flow, 0.25 mm (0.01")	8-14
Percent air voids in mix.	4-8
Percent voids in mineral aggregate	according to article 5.3, MS-2, (Asphalt Institute USA) edition 1993
Loss of stability	25% (Max.)
Filler/Bitumen ratio	1-1.5 (applicable to hot climate (> 40 °C.)

214.2.4 **Combined Aggregates Gradation.**

Retained No. 4	±	7.0%
Passing No. 4 to No. 100 sieves	±	4.0%
Passing No. 200	±	1.0%

Asphalt Content.

Weight percent of total mix.	±	0.3%

Should a change of sources of materials be made a new Job Mix Formula shall be established before the new material is used. When unsatisfactory results or other conditions made it necessary, a new Job Mix Formula will be required.

214.2.5 **Job-Mix Formula.**

At least one week prior to production, a Job-Mix Formula (JMF) for the asphaltic concrete course mixture or mixtures to be used for the project, shall be established jointly by the Engineer and the Contractor.

The JMF shall be established by Marshal Method of Mix Design according to the procedure prescribed in the Asphalt Institute Manual Series No. 2 (MS-2), May 1992 Edition.

The JMF, with the allowable tolerances, shall be within the master range specified in Table Nc. 1. Each JMF shall indicate a single percentage of aggregate passing each required sieve size and a single percentage of bitumen to be added to the aggregates.

After the JMF is established, all mixtures furnished for the project represented by samples taken from the asphalt plant during operation, shall conform thereto with the tolerances as per clause 214.2.4 of these specifications.

214.3 **CONSTRUCTION REQUIREMENTS.**

Construction requirements for this item shall conform with the same construction requirements specified for Asphaltic Concrete Base Course Plant Mix under Item 203.3, except as modified in the following sub-items.

214.3.1 **Preparation of Base Course Surface.**

Before spreading materials the surface of the previously constructed and accepted base course on which the mix is to be placed shall be conditioned by application of a tack/or prime coat, as directed by the Engineer.

214.3.2 **Pavement Thickness and Tolerances.**

The asphalt concrete binder course shall be compacted to the desired level and cross slope as shown on the drawings or as directed by the Engineer.

The tolerances in compacted thickness of the binder course shall be + 10 percent from the desired thickness shown on the drawings. For determination of the thickness, one (1) core per hundred meters of each lane will be taken. If the thickness so determined is deficient by more than + 10 percent, the Engineer shall decide whether to accept the deficit thickness or to direct reconstruction.

The surface of the binder course shall be tested by the Engineer using at 3-meter straight edge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts, longitudinal or transverse with the surface shall at no point ± 5.0 millimeters. The cross fall (camber) shall be within + 0.2 percent of that specified, and the level at any point shall be within drawings. All humps or depressions exceeding the specified tolerance shall be corrected by removing the defective works and replacing it with new material, by overlaying, or by other means satisfactory to the Engineer.

214.4 MEASUREMENT AND PAYMENT.

214.4.1 Measurement

The quantities of asphaltic binder course shall be measured per cubic meter basis.

The quantity of asphaltic material used is included in the asphalt concrete mixture *and will not be measured separately.*

Quantities of liquid asphalt, wasted or remaining on hand after completion of the work, shall not be measured or paid for.

214.4.2 Payment

The quantities determined, as provided above, shall be paid for at the contract unit price respectively for each of the particular pay item listed below and shown in the Bill of Quantities, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item:

Pay Item No.	Description	Unit of Measurement
214	Asphaltic Concrete Binder Course.	CM.

ITEM 215 GEOTEXTILES

215.1 DESCRIPTION

The work covered by this section shall consist in furnishing all material, labour, equipment and placing of Geotextiles on prepared surfaces complete in accordance with the specifications for the work items involved, in thicknesses and to the dimensions shown on the typical cross-sections of applicable drawings or as directed by the Engineer.

215.2 GEOTEXTILE FUNCTIONS

Where indicated on the drawings or directed by the Engineer, Geotextile will be placed to perform one or more of the following functions.

- One road foundation for the purpose of separation between road fill material and soft underlying soils in order to eliminate the need for removal of poor subsoil material and quick and effective drainage of soil-fill interface.
- For subgrade stabilization and increasing soil shear strength by providing bonding mechanism of the Geotextile - soil system.
- As a filter for all drainage systems where a danger of clogging by fine particles of adjacent soil is possible. The geotextile will retain the particles from passing whilst allowing the seepage water to pass through.
- As a filter element for all bodies of water where the soil can be eroded by current, wave action or changing water levels.
- For permanent protection of synthetic sealing systems (Geomembranes) against mechanical damage during installation and after completion of construction.

215.3 MATERIAL REQUIREMENTS

215.3.1 Composition and Environmental Behaviour

The raw material of geotextile shall be Ultra Violet stabilized polypropylene. The fibers shall consist of continuous filaments of approximately 40 micron diameter and mechanically bonded by needling. The geotextile material shall be resistant to acid and alkaline media in the pH range 2 to 13, resistant to lime, cement and concrete, resistant to all naturally occurring bacteria and fungi. A prolonged out side exposure of several months shall have no effect on the properties of Geotextile.

215.3.2 **Mechanical and Hydraulic Properties**

- To ensure free drainage, the geotextile shall have high water permeability.
- Geotextile shall offer high retention capability for almost all types of soils.
- The geotextile shall have optimum stress-strain behaviour even with low unit weight for high resistance against installation damage.

215.4 CONSTRUCTION REQUIREMENTS

215.4.1 Preparation

The surface shall be fairly leveled before placement of Geotextile. It is to be ensured that there are no protruding stones which may damage the geotextile fabric.

215.4.2 Geotextile Placement

The Geotextile shall be rolled out directly on top of the prepared surface in a manner as recommended by the manufacturer. It shall be over lapped at the edges as shown on the drawings or as recommended by the manufacturer.

215.4.3 Placement of fill

The first layer of fill material shall be applied by overhead placement. Traffic on the geotextile itself shall be avoided. Necessary precautions shall be observed to ensure that geotextile shall not be damaged during placement.

215.4.4 Spreading

Spreading of fill material shall be done with suitable equipment and procedure ensuring that geotextile must not be damaged by high axle load stresses of spreading equipment traveling on sharp fill over the geotextile.

215.4.5 Compaction

The compacting method (Static/Dynamic) shall be suited to subgrade/fill material.

215.4.6 Jointing of Geotextile Panels

A tension joint shall be achieved by overlapping, welding or sewing as shown on drawings or approved by the Engineer.

i) Overlapping

Overlapping width shall not be less 30 cm on even surface and 50 cm on uneven surface. In order to avoid displacing the geotextile during backfill over end panel joints, the connecting panel must be placed underneath the end of the previously rolled out geotextile.

ii) Welding

Welding width shall not be less than 10 cm. A wide pattern gas torch shall be used at a low temperature and about 20 cm from the geotextile. The welded geotextile section shall be continuously pressed down by walking on it during placement.

iii) Sewing

The stitching method shall be single thread, double thread or butterfly type suitable to geotextile thread type and strength. The thread shall be sufficiently tightened and stitch density shall be three to six stitches per inch.

215.5 GEOTEXTILE FUNCTION FOR REPAVING

This section deals geotextiles placed between old pavement and new asphalt overlay, alongwith suitable tack coat of bitumen. Where indicated on drawings or directed by the Engineer, geotextile will be placed to perform one or more of the following functions.

- To ensure proper adhesion between old pavement and new asphalt overlay & thus reducing the over all flexural tensile stresses and increasing life of road surface.
- As a cut off layer for the prevention of propagation of cracks in the pavement.
- As water barrier, even under high pressure to stop reflective cracking in the pavements.

215.5.1 Construction Requirements

- Removal of dirt, dust and vegetation from wearing surface and cracks.
- Filling potholes and larger cracks (>5mm) with hot mix or an adequate filler.
- Removal of sharp or craggy edges on surface.
- On badly damaged roads, a level course of approx. 1,5 cm shall be laid to avoid the labour intensive and time consuming operation of crack filling.

215.5.2 Applying the tack coat

Depending on the condition of the old surface, a calculated amount of tack coat (Q_{ef}) of approx. 1.1 kg/m^2 active binder is to be sprayed evenly on the prepared surface before laying geotextile, making sure that:-

- The bitumen is applied beyond the width of the geotextile by about 5 cm on either side.
- The spraying temperature for pure bitumen is kept between 150 °C and 170°C to achieve a coating as even as possible.

- When using bitumen emulsion, the coating amount is adjusted to contain the required average amount of bitumen.
- The coating is only applied to areas where the paving felt is to be laid.
- No additional pre-spray agent is applied on top of the paving felt.
- Where only sections for the road are covered with the paving felts, their surfaces must be gritted.

215.5.3 **Laying Geotextile**

Geotextile shall be laid by hand or machine taking into account that;

- When using pure bitumen as tack coat, Geotextile may be laid immediately after coating.
- When using bitumen emulsions, Geotextile shall not be laid until the emulsion has cured.
- Wrinkles shall be avoided.
- Edges lengthways and across overlap by 5-10 cm, an additional pure bitumen binder of 0.9 kg/m^2 shall be applied on the overlapping seams.
- Transverse overlapping is to be carried out with reference to the direction in which the asphalt finisher will proceed i.e. under the previous one so that the felt does not shift out of place when the asphalt concrete is applied.
- When one half of the road is made (leaving the other open to traffic), at least 25cm of the lengthways felt edge shall remain uncovered to allow overlapping when laying the other half of the road.
- During short time stoppages of construction work, the road under construction shall be opened only to slow traffic without detriment to Geotextile.
- Rain water on the Geotextile surface shall be allowed to evaporate before applying a top layer.

215.5.4 **Applying the asphalt concrete surface**

The asphalt concrete surfacing shall be applied immediately after laying Geotextile preferably by crawler type finisher, taking the following points into consideration.

- The material mix shall have a temperature between 145 °C and 165°C
- To avoid types of the finisher or truck sticking to the felt (which can happen in hot climates or where too much tack coat has been applied), some of the mix can be spread manually in the pathway of the vehicles.

215.6 GEOTEXTILE TESTING

Geotextiles testing shall be in accordance with following standard test methods.

• Weight	ASTM D-3776
• Thickness	ISO 9863
• CBR Puncture Resistance Test	BS 6906/4
• Strip Tensile Test	ASTM D-4595
• Grab Tensile Test	ASTM D-1682
• Tear Strength Test	ASTM D-1117
• Penetration Resistance Test (Drop Test)	NT Build 243
• Vertical Permeability	BS 6906/3
• Pore Size	E DIN 60500/6

Based on the required functions and the type of stresses, the contractor shall propose the type of Geotextile. The contractor shall furnish technical literature and Manufacturer's Certificate of Guarantee for the type of geotextile material for approval of Engineer prior to delivering the material to the site. The certificate shall note compliance to the specifications and shall state the results of the tests performed on the material, as required by the specifications. The Contractor shall, when directed by the Engineer, have the Geotextile material tested for conformance to the applicable specifications at an approved testing laboratory. All costs connected with certificate of Guarantee and any subsequent quality testing shall be at the contractor's expense.

215.7 MEASUREMENT AND PAYMENT

215.7.1 Measurement

The quantity of Geotextile measured to be paid shall be the number of square meters of work completed in accordance with requirement of this item and the limiting dimensions shall not exceed than those shown on the drawings or fixed by the Engineer. Measurement shall only be made of area covered without considering any overlap.

215.7.2 **Payment**

The accepted quantity measured as provided above shall be paid at the contract unit price per square meter of Geotextile laid for the pay item as listed below in the BOQ which price and payment shall constitute full compensation for furnishing all materials, labour, equipment and placing of geotextile.

Pay Item No.	Description	Unit of Measurement
215	Providing and Placing of Geotextile, type-----.	S.M.

ITEM 216 SOLING STONE

216.1 DESCRIPTION

This item shall consist of laying of soling stone, handpacked on a surface (subgrade) prepared earlier and all interstices filled with sand or similar approved materials to provide proper bonding of all the stones with each other.

216.2 MATERIAL REQUIREMENTS

The material for soling shall be round and durable rock, properly shaped or boulders of maximum size 15-20 cm. The filler material to fill the interstices shall be coarse sand or rock dust or any other material approved by the Engineer. Material shall be cohesionless and clean to allow its free flow down to the bottom of soling area.

216.3 CONSTRUCTION REQUIREMENT

216.3.1 The subgrade to receive the soiling stone shall be prepared under relative item of the work.

216.3.2 Placing of Soling Stone

The soling stone shall be placed from outer edges of the road and finishing at the crown of the road in such a way that all stones are properly handpacked and keyed with the surrounding stones. It shall be ensured that the maximum dimension is kept in vertical position ensuring the variation of the size of the stone does not exceed ± 1" of specified thickness of soling stone.

The filler material shall be dry and in free flow condition when placed over the soling stone. The filler material shall be kept adding while the soling stones are rolled under a 6 tons roller. The addition of filler material shall continue till the area does not absorb more material and it is ensured that all interstices are fully filled. The area will than be watered and kept under rolling to achieve a smooth surface.

216.3 MEASUREMENT AND PAYMENT

216.3.1 Measurement

The area to be measured shall be bound by the lines shown on the drawings whereas the normal thickness shall be that which is described in BOQ. The measurement shall be made in CM.

216.3.2 **Payment**

The quantities determined as provided above shall be paid for at the contract unit price for cubic meter which price and payment shall be full compensation for all cost of materials, manpower and equipments involved in the proper completion of work.

Pay Item No.	Description	Unit of Measurement
216	Laying of Soling Stone	CM

ITEM 217 INTERLOCKING CONCRETE PAVING BLOCKS

217.1 DESCRIPTION

The work shall consist of precast concrete paving blocks intended for the construction of low speed roads, parking areas, lay byes, industrial and other paved surfaces subjected to all categories of static and vehicular loading and pedestrian traffic. Paving blocks covered by these Specifications are designed to form a structural element and the surfacing of pavements, having the block to block joints filled, so as to develop frictional interlock and placed in conformity with the lines, grades, thicknesses and typical cross-section shown on the drawings or as directed by the Engineer.

217.2 MATERIAL REQUIREMENTS

For execution of this item provisions made in BS 6717 shall be applicable. Detailed requirement of materials and construction shall be as under:

217.2.1 Binders and Binder Constituents

Paving blocks shall be made using one or more of the following binders or binder constituents complying with the requirements of the relevant standards:

Ordinary Portland Cement	BS 12
Portland Blastfurnace Cement	BS 146 : Part 2
Portland Pulverized Fuel ash Cement	BS 6588
Pulverized fuel ash	BS 3892 : Part 1
Ground granulated Blast furnace slag	BS 6699

Where pulverized fuel ash is used, the proportions and properties of the combination with Portland Cement shall comply with BS 6588.

Where ground granulated blastfurnace slag is used, the proportions and properties of the combination with Portland Cement shall comply with BS 146 : Part 2.

217.2.2 Aggregates

Paving blocks shall be made using one or more of the following aggregates complying with the relevant standards:

Natural Aggregates (Crushed or Uncrushed)	BS 882 : 1983 (except grading requirements in clause 5)
Air Cooled blastfurnace slag	BS 1047 : 1083 (except grading requirements in 4.8)
Pulverized fuel ash	BS 3892 : Part-1 or Part-2
Ground granulated blastfurnace slag	BS 6699