Intech Associates
CONSULTING ENGINEERS

IN ASSOCIATION WITH

Transport Development Strategy Institute

SUPPORTED BY

DFID Department for International Development

MINISTRY OF TRANSPORT VIETNAM

Rural Transport Project 2

RURAL ROAD SURFACING RESEARCH

SEACAP 1

Final Report

Volume 3 of 3

Draft, March 2007

APPENDICES

(Volume 2)

(Volume 3)

This document is an output from projects funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of the DFID.

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX L

RRST Recommended Pavement Specifications

March 2007

RRST Recommended Pavement Specifications

101	BITUMEN EMULSION – SURFACE DRESSING (CHIP EMULSION SEAL)
102	BITUMEN EMULSION – SAND SEAL (SAND EMULSION SEAL)
201	GRAVEL SUB-BASE & BASE
202	LIME STABILISED BASE/SUB-BASE
203	CEMENT STABILISED ROADBASE/SUB-BASE
205	ARMOURED GRAVEL ROAD BASE
206	SAND SUB-BASE
207	QUARRY-RUN SUB-BASE
208	GRADED CRUSHED STONE SUB BASE & BASE
209	SAND BEDDING LAYER
210	DRY- BOUND MACADAM SUB-BASE & BASE
301	FIRED CLAY BRICK PAVEMENT – UNMORTARED JOINTS
302	FIRED CLAY BRICK PAVEMENT – MORTARED JOINTS
303	CEMENT CONCRETE BRICK PAVEMENT
304	MORTARED DRESSED STONE SURFACING
305	COBBLE STONE PAVED SURFACING
401	BAMBOO REINFORCED CONCRETE PAVEMENT (BRC)
402	STEEL REINFORCED CONCRETE PAVEMENT (SRC)
403	NON-REINFORCED CONCRETE PAVEMENT (NRC)

DRAFT SPECIFICATION RRST 101

BITUMEN EMULSION – SURFACE DRESSING (CHIP EMULSION SEAL)

101.1 DESCRIPTION

Surface Dressing consists of supply and application of a seal of bituminous binder material over a previously prepared surface. The seal is immediately covered with single sized stone aggregate chippings. The chippings completely cover the seal and are lightly rolled into the seal to form an interlocking mosaic. When one application of bituminous material and aggregate is placed it is termed as Single Bituminous Surface Dressing (SBSD). When two applications of bituminous material and aggregate are placed it is termed as Double Bituminous Surface Dressing (DBSD). The surface dressing acts as a waterproof seal and running surface.

101.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Rapid setting CATIONIC emulsion (RS) grades are the best suited to surface dressing work to achieve rapid development of the bond between the bitumen and the other materials. Other grades may be specified in some circumstances.

Bitumen emulsion shall be from an established supplier able to provide the documentation to demonstrate compliance with the specifications. Bitumen emulsion shall comply with the current Vietnam standard (22TCN 250-98). Emulsion shall be used within 3 months of manufacture and regularly agitated (rolled if stored in drums) during storage to prevent premature separation of the components.

The Contractor shall provide for each source of bitumen emulsion a report on its composition, grade, and date and place of manufacture.

Anionic and Cationic emulsions should never be mixed in the raw state. Equipment or containers used for one type should be thoroughly cleaned before using with the other.

Prime Emulsion

Cationic emulsion of Medium Setting (MS) or Slow Setting (SS) grade shall be used and diluted as per Clause 101.3 below. Residual bitumen in the undiluted emulsion shall be 60% of penetration (at 25°C) 80 Pen or more.

Seal Emulsion

Cationic emulsion of Rapid Setting (RS) grade shall be used. Residual bitumen in the emulsion shall be 60 – 65% of penetration (at 25°C) 40 - 90 Pen.

Water

Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste.

Chippings

These shall be machine crushed or manually broken fresh material that may include, quarried rock, natural granular material such as rocks, gravel or boulders. The material shall be single sized, separated by screening. After crushing/breaking, the material should be angular in shape meeting the following requirements:

Either	TCVN 1772-87:	<35%
	or	
	22TCN 57-84	<5%

Plus :

- Water absorption shall not exceed 2%.
- Los Angeles Abrasion (LAA) value not more than 35 or as directed by the Engineer.
- Adhesion between stone chipping and bitumen emulsion as per 22-TCN-63-84); Minimum Grade 3 required

Three sizes of stone chipping may be specified:- 10-14mm nominal,
6-10mm nominal,
4-6mm nominal.

The following are the recommended grading limits for the stone chippings:-

Grading Limits (mm)	Nominal size of aggregates (mm)		
	10-14	**6-10**	**4-6**
20	100	-	-
14	85 – 100	100	-
10	0 – 40	85 – 100	100
6.3	0 – 7	0 – 35	85 – 100
5	-	0 – 10	-
3.35	-	-	0 – 35
2.36	0 – 3	0 – 3	0 – 10
0.600	0 – 2	0 – 2	0 – 2
0.075	-	-	-

6-10 or 10-14 mm is normally specified for the first or only seal. 4-6mm should be used for a second seal where this is specified.

Aggregate shall be clean, free from organic matter. Clay content shall be not more than 2%. Aggregates shall be of the quality shown in the following table, only chippings complying with Classes 3 – 1 may be used:

Types of Aggregate	Class	Compression Strength (daN/cm²)
Magma (granite, syenite, gabbro…..)	1 2 3	1,200 1,000 800
Weathered stone (Gneiss, quartzite…..)	1 2 3	1,200 1,000 800
Sediment (Limestone, dolomite)	1 2 3	1,000 800 600

101.3 CONSTRUCTION METHODS

Prior to laying the surface dressing, the Contractor shall correct any deformations, ruts, soft spots or other defects in the roadbase to the satisfaction of the Engineer whose approval shall be obtained before surface dressing works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed. The roadbase or existing surface shall be prepared to the correct shape and cross fall. The edges of the area to be surface dressed will be clearly marked out using ropes or other methods.

All aggregates shall be stored on site in clean dry areas adjacent to the place of construction. If stored on the road way, the stockpiles shall be well marked and positioned to ensure safe passage of traffic, particularly at night.

Construction of surface dressing shall only be carried out in dry weather. The roadbase shall also be dry throughout. The air shade temperature during construction shall not be lower than 15°C.

Unless the roadbase or working surface is a bitumen stabilised material recently completed, the surface of the roadbase will need to be primed. The surface to be primed must be clean and free from dust, loose material etc. which should be removed by brooming. The surface shall be primed by lightly spraying with a diluted Cationic emulsion. at the rate of 0.5 – 0.6 litres of diluted emulsion per square metre. The emulsion dilution with water shall be dependant on the surface to be primed, as follows (emulsion:water):

Open, granular base (e.g. water bound or dry bound macadam): dilution 1:1 or 1:2
Tight smooth surfaces (e.g. existing seals or stabilised local soil); dilution 1: 10

The main seal may be applied after the prime has completely dried.

Aggregate chippings shall be placed along the side of the road in heaps ready to apply as soon as the seal emulsion is in place. The spacing and size of the heaps will

be calculated from the rate of application of chippings, determined from the Average Least Dimension of the aggregates.

The application of un-heated Cationic bitumen emulsion shall be made to the road surface. The rate of application will depend on aggregate size and characteristics calculated on the basis of the Average Least Dimension. The rate should be determined from trials to achieve that the residual bitumen extends to 75% of the height of the chipping after compaction and bedding in. The following residual bitumen rates may be used as general indication:-

10-14mm chippings:	1.28 litres/m²
6-10mm chippings:	0.97 litres/m²
4-6mm chippings:	0.78 litres/m²

The application of the bitumen emulsion may be made by spray bar, hand lance or by hand application. Rates of application shall be regularly checked to ensure consistency and compliance.

Immediately after the application of bitumen emulsion, the stone chipping application is made by hand from the adjacent stockpiled heaps. The application shall be sufficient to cover the bitumen seal completely. The surface will be lightly rolled immediately with an approved roller with NO vibration making 4/6 passes per point, at a speed of approximately 2 km/h. Additional chippings will be applied by hand if necessary to deficient areas. Excess chippings shall be left in place to be bedded in or displaced by the traffic.

The completed surface dressing shall be allowed to dry out and cure before opening to traffic, which should take one or two days depending on conditions. Traffic should be restricted in speed during the first week until bedding in has taken place. Excess chippings shall then be broomed and collected before the road is opened to unrestricted traffic.

If specified, the second seal shall be applied as above using the appropriate stone grading as specified. No prime is required between the first and second seals unless:

1. There has been a long construction delay between seals, or
2. A prime is specifically required by the Supervising Engineer.

101.4 CONSTRUCTION EQUIPMENT

The following equipment will be required:

Deadweight Roller	Number of Passes
I Tonne Minimum: 3 Tonne Maximum	4-6 per point after stone application

Bitumen Distributor

Bitumen distributor and spray bar/hand lance, or manual distribution containers.

The type and condition of the equipment shall be approved by the Supervising Engineer.

101.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of single or double surface dressing bitumen emulsion chip seal. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, heating, incidentals necessary, overheads and profit for the prime and seal.

Pay Items shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
101a	Single Surface Dressing Bitumen Emulsion Chip Seal (including Prime)	Square metre
101b	Double Surface Dressing Bitumen Emulsion Chip Seal (including Prime)	Square metre

If the required rates of spread of residual bitumen are more than the rates quoted in Clause 101.3, the Engineer may adjust the rate of payment for the additional material used.

101.6 LABORATORY & SITE TESTING

General

The Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution of chippings	One per 1.0km aggregate chippings (more frequently if material character changes)
Los Angeles Abrasion Value	As above
Aggregate Water Absorption	As above
Aggregate Shape	As above
Aggregate–bitumen emulsion adhesion	One per source
Bitumen Emulsion: Residue by distillation % Residue Penetration at 25°C	One per source

Materials from each source should be submitted to the Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Engineer for approval.

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications.

TYPE OF TEST	FREQUENCY OF TEST
Rate of spread of residual bitumen	Per working shift

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the surface dressing by the Engineers Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 102

BITUMEN EMULSION – SAND SEAL (SAND EMULSION SEAL)

102.1 DESCRIPTION

A sand seal consists of supply and application of a seal of bituminous binder material over the previously prepared road base. The seal is immediately covered with sand or fine aggregate chippings. The sand/fine aggregate completely covers the seal and is lightly rolled into the seal to form a weather proof matrix and running surface suitable for light vehicular traffic.

102.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Bitumen emulsion shall be from an established supplier able to provide the documentation to demonstrate compliance with the specifications. Bitumen emulsion shall comply with Vietnam Standard (22TCN 250-98). Emulsion shall be used within 3 months of manufacture and regularly agitated (rolled if stored in drums) during storage to prevent premature separation of the components.

The Contractor shall provide for each source of bitumen emulsion a report on its composition, grade, and date and place of manufacture.

Anionic and Cationic emulsions should never be mixed in the raw state. Equipment or containers used for one type should be thoroughly cleaned before using with the other.

Prime Emulsion

Cationic emulsion of Medium Setting (MS) or Slow Setting (SS) grade shall be used and diluted as per Clause 102.3 below. Residual bitumen in the undiluted emulsion shall be 60% of penetration (at 25°C) 80 Pen or more.

Seal Emulsion

Cationic emulsion of Rapid Setting (RS) grade shall be used. Residual bitumen in the emulsion shall be 60 – 65% of penetration (at 25°C) 40 - 90 Pen.

Water

Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste.

Sand/Fine Aggregate

This shall be natural sand or fine aggregate that has been machine crushed or manually broken and screened material that may include, quarried rock, natural granular material such as fresh rock, gravel or boulders. Aggregate shall be clean, free from organic matter. Clay content shall be not more than 2%.

The maximum particle size shall be 6mm. No more than 15% of material shall be finer than 0.15mm. Sand or fine aggregate shall be applied at the rate of 6 – 7 litres/m².

102.3 CONSTRUCTION METHODS

Prior to laying the sand seal, the Contractor shall correct any deformations, ruts, soft spots or other defects in the roadbase or road surface to the satisfaction of the Supervising Engineer whose approval shall be obtained before surface dressing works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed. The roadbase or existing surface shall be prepared to the correct shape and cross fall. The edges of the area to be sand sealed will be clearly marked out using ropes or other methods.

All aggregates shall be stored on site in clean dry areas adjacent to the place of construction. If stored on the road way, the stockpiles shall be well marked and positioned to ensure safe passage of traffic, particularly at night.

Construction of sand seal shall only be carried out in dry weather. The roadbase shall also be dry throughout. The air shade temperature during construction shall not be lower than 15°C.

Unless the roadbase or working surface is a bitumen stabilised material recently completed, the surface of the roadbase will need to be primed. The surface to be primed must be clean and free from dust, loose material etc. which should be removed by brooming. The surface shall be primed by lightly spraying with a diluted Cationic emulsion. at the rate of 0.5 – 0.6 litres of diluted emulsion per square metre. The emulsion dilution with water shall be dependant on the surface to be primed, as follows (emulsion:water):

Open, granular base (eg water bound or dry bound macadam): dilution 1:1 or 1:2
Tight smooth surfaces (eg existing seals or stabilised local soil); dilution 1: 10

The main seal may be applied after the prime has completely dried.

Sand or fine aggregate shall be placed along the side of the road in heaps ready to apply as soon as the seal emulsion is in place. The spacing and size of the heaps will be calculated from the rate of application of about 6 – 7 litres/m².

The application of un-heated Cationic bitumen emulsion shall be made to the road surface. The rate of application will depend on aggregate characteristics. The rate should be determined from trials to achieve that the residual matrix is complete, but does not ‘bleed’ excessive bitumen. The following rates are a guideline:-

Residual Bitumen application rate: 0.70 litres/m²

The application of the bitumen emulsion may be made by spray bar, hand lance or by manual application. Rates of application shall be regularly checked to ensure consistency and compliance.

Immediately after the application bitumen emulsion, the sand/fine aggregate chipping application is made by hand from the adjacent stockpiled heaps. The application shall be sufficient to cover the bitumen seal completely. The surface will be lightly rolled immediately with an approved roller with NO vibration making 2/4 passes per point, at a speed of approximately 2 km/hour. Additional sand/fine aggregate chippings will be

applied by hand if necessary to deficient areas. Excess sand/fine material shall be left in place to be bedded in or displaced by the traffic.

The completed sand seal shall be allowed to dry out before opening to traffic, which should take one or two days depending on conditions. Traffic should be restricted in speed during the first week until bedding in has taken place. Excess sand shall then be broomed and collected before the road is opened to unrestricted traffic.

102.4 CONSTRUCTION EQUIPMENT

The following equipment will be required:

Deadweight Roller Weight	Number of Passes
1Tonne minimum – 3 Tonne maximum	2-4 per point after sand application

Bitumen Distributor

Bitumen distributor and spray bar/hand lance, or manual distribution containers.

The type and condition of the equipment shall be approved by the Supervising Engineer.

102.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of single bitumen emulsion sand seal. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, heating, incidentals necessary, overheads and profit for the prime and seal.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
102	Bitumen Emulsion Sand Seal (including Prime)	Square metre

102.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the

Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution of sand/fine aggregate	One per 1.0km on sand/fine aggregate (more frequently if material character changes)
Bitumen Emulsion: Residue by distillation % Residue Penetration at 25°C	One per source

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications.

TYPE OF TEST	FREQUENCY OF TEST
Rate of spread of residual bitumen	Per working shift

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the sand seal by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION 201

GRAVEL SUB-BASE & BASE

201.1 DESCRIPTION

The work comprises providing, laying and compacting approved gravel to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer.

201.2 MATERIALS

The following paragraphs reference target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

This pavement layer shall be constructed from naturally occurring gravels from sources approved by the Engineer according to the requirements of Tables 1 and 2 in 22 TCN 304-03.

201.3 CONSTRUCTION METHODS

Prior to laying the sub-base or base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the underlying layer or formation to the satisfaction of the Supervising Engineer whose approval shall be obtained before gravel works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

Material for the construction of the sub-base or base shall be dumped on the prepared formation in such a manner as to allow for continuity of operations over the length of the formation and to cause least inconvenience and danger to traffic.

Spreading of the material shall be by manual or machine methods and shall be in such a manner as to allow the free flow of traffic through the works. The spreading shall be in layers each not exceeding 150 mm loose thickness to build up and form the final compacted thickness shown on the drawings.

Compaction shall be carried out and completed on each layer before the next loose layer is placed. Compaction shall be in a series of continuous operations covering the full width and length of the layer concerned. Water should be added as necessary to facilitate compaction.

The target in-situ strength of the compacted gravel layers shall be not less than CBR 30% for sub-base (at k=0.95 Modified AASHTO) and CBR 55% for base (at k=0.98 Modified AASHTO) as measured by the Dynamic Cone Penetrometer (DCP) method

Water should be added as necessary to facilitate compaction.

The gravel material shall, on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All extraneous matter, loose, segregated or otherwise defective areas shall be removed and made good with new material to the full thickness of the layer.

Component layer thickness tolerances to be -5 mm to +15 mm.

201.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range:

Vibrating Roller Minimum Weight	Number of Passes
Minimum 3 Tonne	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

201.5 MEASUREMENT

The unit of measurement shall be cubic metres (m^3) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width, the instructed compacted thickness and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
201.1	Gravel Sub- Base	Cubic metre
201.2	Gravel Base	Cubic metre

201.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Modified AASHTO compaction	One per material source
4 Day Soaked CBR at 95% Modifed AASHTO	One per material source (more frequently if material character changes)
Particle Size Distribution	One per 1km (more frequently if material character changes)
Atterberg Limits	As above

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
In situ strength by DCP (set of 3)	3 per 1km or at change of material
In situ density	As above
Placed Compacted Material layer thickness	See following requirements

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations.

Visual inspections will be made to check compliance with the drawings and specifications.

Shallow inspection pits shall be excavated through the completed sub-base on centre line and 0.5 metres from each edge of the road base every 1.0 km and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 202

LIME STABILISED BASE/SUB-BASE

202.1 DESCRIPTION

In general, this Specification Clause follows the guidelines laid down in Transport Sector Standard 22TCN81-84 and covers the provision, placement, compaction and curing of lime stabilised soil materials as shown on the Engineering Drawings or as directed by the Supervising Engineer.

202.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Lime to be used in stabilisation shall be in its powdered hydrated form [Ca(OH)2], with 100% passing 2mm and 80% passing the 0.1mm sieves.

The Contractor shall provide for each source of lime a report of a chemical analysis indicating the amount of "available lime". Lime contents shall be determined prior to the commencement of work and the agreed lime content for the work expressed in terms of "available lime" content throughout.

Materials to be treated shall be naturally occurring, approved, soils of sub-grade standard, with organic contents less than 6% and chloride and sulphate salts less than 4% by weight. Properties of materials suitable for improvement and/or stabilisation for sub-base and base are indicated in the RRST Construction Guidelines document.

The soils shall be tested to establish the amount of lime required to improve them for use in the layers proposed in the design and as indicated on the Drawings. The amount of lime required shall be established from laboratory tests and will depend on the amount of free lime, the material to be treated and the use to be made of the treated material. As a guide, when using hydrated lime, the amount usually required to improve materials for sub-base will be 3 to 5% and to improve materials for road base layers will be 4 to 8%. These percentages relate to the dry weight of the soil.

Stabilised soil shall have the following laboratory tested CBR strengths after a 21 day cure and 7 day soaking period:

Sub-base: CBR 30% at 95% Modified AASHTO
Base: CBR 55% at 98% Modified AASHTO

During processing sufficient water shall be available in the material to facilitate mixing. Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste.

202.3 CONSTRUCTION METHODS

Placing and Mixing

The final amount of lime required on site shall be as directed by the Supervising Engineer, based on amounts assessed in the laboratory tests plus an additional 1% and will be a function of:

- The amount of free lime,
- The nature of the material to be treated
- The use to be made of the treated material
- The machinery proposed for in situ mixing

Imported approved soil shall be placed on a previously prepared and approved sub-base or formation to a loose thickness sufficient to achieve the final compacted thickness as detailed on the Engineering drawings. Unless otherwise directed by the Supervising Engineer, the material shall be treated in a single layer if its compacted thickness is 150 mm or less. Maximum thickness to be compacted in any layer may be reduced by the Supervising Engineer to a thickness capable of being effectively mixed by the available mixing plant.

The in-situ or imported soil to be treated shall be processed by breaking up, reducing to a fine tilth and mixing using approved rotovators. If the soil is hard it should be loosened initially by hand-tools or scarifying equipment. The soil processing should ensure that particles over 5mm do not exceed 25% and those over 10mm do not exceed 10% by weight. The soil moisture content should generally be 2-3% lower than the standard optimum content.

After breakdown the material shall be shaped and the layer tamp sealed with a single pass by a roller.

Lime shall be uniformly spread on top of the layer to be stabilised. Bags of lime shall be accurately spaced at equal intervals along and across the section to be treated so as to provide the specified rate of application. The bags shall be opened and the lime spread by hand tools firstly in transverse rows over the full width to be treated. Spreading shall be done as evenly as possible and uniform distribution of the lime over the entire surface to be treated shall then be attained by levelling off the lime by hand rakes and/or screeds. Labourers should wear appropriate clothing to prevent skin contact with lime materials. Lime placing, spreading and mixing shall not be carried out in wet weather, or in dry windy conditions that allow the material to be air dispersed or adversely affect the labourers.

Immediately after the lime has been spread, it shall be mixed with the loose soil for the full depth of treatment. Further addition of water to achieve the target design moisture content should only be carried out after an initial dry mixing phase. Particular care shall be taken to ensure satisfactory moisture distribution over the full depth, width and length of the section being treated and to prevent any portion of the work from getting excessively wet after the lime has been added. Any area of the work that

becomes too wet after the lime has been added and before the mixture has been fully compacted, will be rejected.

Care shall be exercised not to disturb any compacted layer underneath, nor to mix the lime below the required depth. Mixing shall be continued and repeated as often as may be required to ensure a thorough, uniform and intimate mix of the soil and lime over the full width, length and depth of the material being treated. The final mixture shall be homogeneous and of uniform appearance throughout.

Compaction

Final compaction and shaping shall be completed within 24 hours of mixing, before initial hardening of the stabilised soil. Compaction shall be carried out with an approved vibrating roller, as specified in Specification Clause 202.4.

Compaction shall be carried out in a series of continuous operations covering the full width and length of the layer concerned. The Supervising Engineer reserves the right to reduce the lengths of sections being treated at any time when he considers that the sections are too long to be compacted by the available equipment, or when specified compaction levels are not being achieved. The types of compaction equipment to be used and the number of passes to be made shall be such as to ensure the specified target density and strengths are achieved without damaging the target layer or any underlying layer.

The target DCP strengths at the specified compaction levels for the lime-stabilised layers are as follows:

Roadbase	CBR: 55% by DCP after 21 days curing; k=0.98, Modified AASHTO
Sub-base	CBR: 30% by DCP after 21 days curing; k=0.95, Modified AASHTO

Curing

The finished layer must be cured for a period of 28 days to ensure that sufficient moisture is retained to allow the lime to hydrate, reduce shrinkage, prevent cracking due to shrinkage and reduce carbonation of the top surface.

In the cases where the road base is not to be emulsion sealed, a layer of sand, 40 to 50mm thick, may be spread over the treated material and kept damp by regular watering to achieve the necessary curing. The material forming the protective layer shall be watered at such intervals as may be required to keep the treated layer continuously wet or damp. These intervals shall not exceed 24 hours in dry weather.

Traffic or any other equipment, other than that involved in the curing process, shall not be allowed onto the treated material for the first seven days after compaction.

In the case of a 2-layer construction the second layer construction may be carried out immediately after compaction of the first layer is completed and approved by the Supervising Engineer's Representative.

202.4 CONSTRUCTION EQUIPMENT

Breaking up & Mixing

The in-situ or imported soil to be treated shall be processed by breaking up, reduction and mixing using a single axle tractor rotovator or 2-axle tractor driven rotovator with blades capable of mixing to a loose material depth of 20 cm or more.

Compaction

Compaction of the mixed material shall be carried out by the following equipment:

Vibrating Roller Minimum Weight	Number of Passes
3 Tonne	6-8 per point

The type and condition of the mixing and compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

Watering Equipment

The water supply and watering equipment shall be adequate to ensure that all water required is added and mixed with the material being treated within a short enough period to enable compaction and finishing to be completed within the specified period.

202.5 MEASUREMENT

Lime stabilisation of local soil layers shall be measured by the cubic metres of placed, compacted and cured layers on the road. The quantity of work will be calculated by multiplication of the actual instructed thickness implemented by the width and approved length of the road along the centre line of the road.

The rates shall include the supply, placing, mixing, compaction, shaping, and curing as specified and shown on the Drawings. Final adjustment of the rates may be considered, based on the percentages of lime required by the Supervising Engineer.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Items shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
202.1	Lime Stabilised Roadbase	Cubic metre
202.2	Lime Stabilised Sub-Base	Cubic metre

202.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution	One per 1km (more frequently if material character changes))
Atterberg Limits (stabilised and non-stabilised)	As above
Lime Content	One per 1km
Modified AASHTO compaction (stabilised and non-stabilised)	One per material source
CBR on soil stabilised at required lime content and at required compaction level	One per material source.
CBR on site mixed soil and lime at required compaction level	One per 1km or as directed by the Supervising Engineer

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
In situ strength by DCP (set of 3)	3 sets per 1km or at change of material
In situ density	As above
Placed Compacted Material layer thickness	See below

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations.

Visual inspections will be made to check compliance with the drawings and specifications.

Shallow inspection pits shall be excavated through the completed sub-base, road base and shoulder on centre line and 0.5 metres from each edge of the road base every 1.0 km and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 203

CEMENT STABILISED ROADBASE/SUB-BASE

203.1 DESCRIPTION

In general, this Specification Clause follows the guidelines laid down in Transport Sector Standard 22TCN81-84 and covers the provision, placement and compaction of cement stabilised local soil materials as shown on the Engineering Drawings or as directed by the Supervising Engineer.

203.2 MATERIALS

The following paragraphs define target specifications for materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Portland or other kinds of cement used for stabilisation shall meet the requirements defined in the following:

- Cement – Chemical Testing Methods: TCVN 140-64
- Cement – Mechanic Testing Methods: TCVN 140-64

In general, cement grade 300 or better may be used for soil stabilisation. The Contractor shall provide for each source of cement a report on its composition and grade. Reports on cement grade and condition shall be determined prior to the commencement of work and throughout the construction period as required by the Supervising Engineer.

Materials to be treated shall be naturally occurring, approved, soils of sub-grade standard, with organic contents less than 6% and chloride and sulphate salts less than 4% by weight. Properties of materials suitable for improvement and/or stabilisation for sub-base and base are indicated in the RRST Construction Guidelines document.

The soils shall be tested to establish the amount of cement required to improve them for use in the layers proposed in the design and as indicated on the Drawings. The amount of cement required shall be established from laboratory tests and will depend on the grade of cement, the material to be treated and the use to be made of the treated material. As a guide, when using cement, the amount usually required to improve materials for sub-base will be 2 to 4% and to improve materials for road base layers will be 4 to 7%. These percentages relate to the dry weight of the soil.

Stabilised soil shall have the following laboratory tested Unconfined Compressive Strength (UCS) after a 7 day cure and 7 day soaking period:

Sub-base: UCS: 0.14MPa at 95% Modified AASHTO
Base: UCS: 0.26MPa at 98% Modified AASHTO

(Assuming UCS = 0.00468 x CBR%)

During processing sufficient water shall be available in the material to facilitate mixing.Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste.

203.3 CONSTRUCTION METHODS

The final amount of cement by weight required shall be as directed by the Supervising Engineer, based on laboratory tests and will depend on the amounts assessed in the laboratory tests plus an additional 1% and will be a function of:

- The amount of free cement,
- The nature of the material to be treated
- The use to be made of the treated material
- The machinery used for in situ mixing

.

Imported material for stabilisation shall be placed on a previously prepared and approved sub-base or formation to a loose thickness sufficient to achieve the final compacted thickness as detailed on the Engineering drawings. Unless otherwise directed by the Supervising Engineer, the material shall be treated in a single layer if its compacted thickness is 150 mm or less. Maximum thickness to be compacted in any layer may be reduced by the Supervising Engineer to a thickness capable of being effectively mixed by the available mixing plant.

The in-situ or imported materials to be treated shall be processed by breaking up, reducing to a fine tilth and mixing using approved rotovators. If the soil is hard it should be loosened initially by handtools or scarifying equipment. The soil processing should ensure that particles over 5mm do not exceed 25% and those over 10mm do not exceed 10% by weight. The soil moisture content should generally be 3-4% lower than the standard optimum content.

After breakdown the material shall be shaped and the layer tamp sealed with a single pass by a roller.

Cement shall be uniformly spread on top of the layer to be stabilised. Bags of cement shall be accurately spaced at equal intervals along and across the section to be treated so as to provide the specified rate of application. The bags shall be opened and the cement spread by hand tools firstly in transverse rows over the full width to be treated. Spreading shall be done as evenly as possible and uniform distribution of the cement over the entire surface to be treated shall then be attained by levelling off the cement by hand rakes and/or screeds. Labourers should wear appropriate clothing to prevent skin contact with cement materials. Cement placing, spreading and mixing shall not be carried out in wet weather, or in dry windy conditions that allow the material to be air dispersed or adversely affect the labourers.

Immediately after the cement has been spread, it shall be mixed with the loose soil for the full depth of treatment. Further addition of water to achieve the target design moisture content should only be carried out after an initial dry mixing phase. Particular care shall be taken to ensure satisfactory moisture distribution over the full depth, width and length of the section being treated and to prevent any portion of the work from getting excessively wet after the cement has been added. Any area of the work that becomes too wet after the cement has been added and before the mixture has been fully compacted, will be rejected.

Care shall be exercised not to disturb any compacted layer underneath, nor to mix the cement below the required depth. Mixing shall be continued and repeated as often as may be required to ensure a thorough, uniform and intimate mix of the soil and cement over the full width, length and depth of the material being treated. The final mixture shall be homogeneous and of uniform appearance throughout.

Compaction

Final compaction and shaping shall be completed within 6 hours of mixing, before hardening of the stabilised soil. Compaction shall be carried out with an approved vibrating roller, as specified in Specification Clause 203.4..

Compaction shall be carried out in a series of continuous operations covering the full width and length of the layer concerned. The Supervising Engineer reserves the right to reduce the lengths of sections being treated at any time when he considers that the sections are too long to be compacted by the available equipment, or when specified compaction levels are not being achieved. The types of compaction equipment to be used and the number of passes to be made shall be such as to ensure the specified target density and strengths are achieved without damaging the target layer or any underlying layer.

The target DCP strengths at the specified compaction levels for the cement-stabilised layers are as follows:

Roadbase	CBR: 55% by DCP after 21 days curing; k=0.98, Modified AASHTO
Sub-base	CBR: 30% by DCP after 21 days curing; k=0.95, Modified AASHTO

Curing

The finished layer must be cured for a period of 7 days to ensure that sufficient moisture is retained to allow the cement to hydrate, reduce shrinkage, prevent cracking due to shrinkage and reduce carbonation of the top surface.

In the cases where the road base is not to be emulsion sealed, a layer of sand, 40 to 50mm thick, may be spread over the treated material and kept damp by regular watering to achieve the necessary curing. The material forming the protective layer shall be watered at such intervals as may be required to keep the treated layer continuously wet or damp. These intervals shall not exceed 24 hours in dry weather.

Traffic or any other equipment, other than that involved in the curing process, shall not be allowed onto the treated material for the first seven days after compaction.

In the case of a 2-layer construction the second layer construction may be carried out immediately after compaction of the first layer is completed and approved by the Supervising Engineer's Representative

203.4 CONSTRUCTION EQUIPMENT

Breaking up & Mixing

The in-situ or imported soil to be treated shall be processed by breaking up, reduction and mixing using:a single axle tractor rotovator or 2-axle tractor driven rotovator with blades capable of mixing to a loose material depth of 20 cm or more.

Compaction

Compaction of the mixed material shall be carried out by the following equipment:

Sub-base or Roadbase:

Vibrating Roller Minimum Weight	Number of Passes
3,000 kg	6-8 per point

The type and condition of the mixing and compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations..

Watering Equipment

The water supply and watering equipment shall be adequate to ensure that all water required is added and mixed with the material being treated within a short enough period to enable compaction and finishing to be completed within the specified period.

203.5 MEASUREMENT

Cement stabilisation of local soil layers shall be measured by the cubic metres of placed, compacted and cured layering on the road. The quantity of work will be calculated by multiplication of the actual instructed thickness implemented by the width and approved length of the road along the centre line of the road.

The rates shall include the supply, placing, mixing, compaction, shaping, and curing as specified and shown on the Drawings. Final adjustment of the rates may be considered, based on the percentages of cement required by the Supervising Engineer.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Items shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
203.1	Cement Stabilised Roadbase	Cubic metre
203.2	Cement Stabilised Sub-Base	Cubic metre

203.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the

frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution	One per 1km (more frequently if material character changes))
Atterberg Limits(stabilised and non-stabilised)	As above
Cement Content	One per 1km
Modified AASHTO compaction (stabilised and non-stabilised)	One per material source
UCS on soil stabilised at required lime and compaction	One per material source.
UCS on site mixed soil and lime compacted at required level	One per 1km or as directed by the Supervising Engineer

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
In situ strength by DCP (set of 3)	3 per 1km or at change of material
In situ density	As above

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations

Visual inspections will be made to check compliance with the drawings and specifications.

Reports on available cement content shall be submitted to the Supervising Engineer for his approval prior to the incorporation of lime in the permanent works and at weekly or other intervals as agreed by the Supervising Engineer.

Shallow inspection pits shall be excavated through the completed sub-base, roadbase and shoulder on centre line and 0.5 metres from each edge of the road base every 1.0 km *section*) and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 205
ARMOURED GRAVEL ROAD BASE

205.1 DESCRIPTION

This activity has two components: an initial component of natural gravel laid to camber, watered and compacted, followed by a layer or armouring of crushed/broken stone aggregate laid to camber, watered and compacted.

The work comprises providing, laying and compacting approved gravel and armouring materials to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer.

A surface seal would normally be applied to the road base as a separate specification item.

205.2 MATERIALS

The following paragraphs define target specifications for materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

205.2.1 Gravel Layers

The pavement layer(s) shall be constructed from naturally occurring gravels approved by the Supervising Engineer according to the requirements of Specification Clauses 205. However the additional construction and testing requirements in Specification Clause 205.3 to 205.6 apply.

205.2.2 Aggregate Armouring Layer

This is crushed fresh material that may include, quarried rock, natural granular material such as rocks, gravel or boulders. The materials shall be separated by screening and then recombined to produce the required particle distribution if necessary. After crushing, the material shall comply with the following requirements:

- Water absorption shall not exceed 2%.
- Los Angeles Abrasion (LAA) value not more than 35 or as directed by the Supervising Engineer.
- Shape: TCVN 1772-87 <35% or 22TCN 57-84 <10%
- Plasticity Index of binding materials shall not more than 6.
- Fineness Modulus of sand fraction shall not be less than 1.80 and shall be free from deleterious materials.

The materials shall be well graded and conform to the following grading limits:

Sieve size	***Passing the sieve (% by mass)***
	Nominal maximum particle size: 37.5 (mm)
50	*100*
37.5	*80-100*
20	*60-90*
10	*40-70*
5	*30-55*
2.36	*20-45*
0.425	*8-30*
0.075	*5-15*

The armouring layer shall have the following DCP tested CBR strength and density after it has been cured and set:

CBR 55% at 98% modified AASHTO

205.3 CONSTRUCTION METHODS

Prior to laying the road base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation or sub-base all to the satisfaction of the Supervising Engineer whose approval shall be obtained before gravel/laterite roadbase works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

205.3.1 Gravel Layers

Prior to laying the sub-base or base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the underlying layer or formation to the satisfaction of the Supervising Engineer whose approval shall be obtained before gravel works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

Material for the construction of pavement layer(s) shall be dumped on the prepared formation in such a manner as to allow for continuity of operations over the length of the formation and to cause least inconvenience and danger to traffic.

Spreading of the material shall be by manual or machine methods and shall be in such a manner as to allow the free flow of traffic through the works. The spreading shall be in layers each not exceeding 150 mm loose thickness to build up and form the final compacted thickness shown on the drawings.

Compaction shall be carried out and completed on each layer before the next loose layer is placed. Compaction shall be in a series of continuous operations covering the full width and length of the layer concerned. Water should be added as necessary to facilitate compaction.

The target in-situ strength of the completed gravel layers shall be not less than CBR CBR 55% as measured by the Dynamic Cone Penetrometer (DCP) method at the specified compaction level of k=0.98 (Modified ASSHTO)

Water should be added as necessary to facilitate compaction.

The gravel material shall, on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All extraneous matter, loose, segregated or otherwise defective areas shall be removed and made good with new material to the full thickness of the layer.

205.3.2 Aggregate Armouring Layer

This work shall consist of the supply, mixing, placing, shaping and compaction of an aggregate armouring layer composed of a broken stone aggregate mechanically interlocked by watering, rolling and bonded together with screening, binding materials where necessary to the Specifications and to the lines, levels, dimensions and cross-falls shown on the Drawings or as directed by the Supervising Engineer.

Spreading of Aggregate:

The aggregate shall be spread uniformly upon the prepared laterite layer in quantities such as to comply with the specified final compacted thickness. Any segregation of the dumped material shall be reworked by labourers with hand tools. The surface of the aggregate shall be carefully finished with the aid of templates and levelling of all high or low spots by removing or adding aggregates as may be the case. The irregularities are much easier to correct in loose layer than later.

Dry rolling:

Immediately following the spreading of aggregate, it is to be first rolled dry with the aid of an approved vibratory roller. The rolling shall begin from edges with roller running forward and backward, parallel to the centreline of the road until the layer has been firmly compacted. Rolling shall continue until the material matrix is thoroughly keyed and stone creeping ahead of the roller in no longer visible. Light sprinkling of water may be required to assist compaction. The rolled surface shall be checked transversely and longitudinally with templates and if the irregularities exceed 12 mm from the required plane, the surface should be loosened and aggregate added or removed before rolling again. In no case shall the use of screenings be permitted to make up depressions.

Watering and Wet rolling:

After the dry rolling, the surface shall be copiously sprinkled with water, swept and rolled with the approved vibratory roller. Hand brooms shall be used to sweep the wet screenings into voids and distribute them evenly. The sprinkling, sweeping, and rolling operations shall be continued, with additional screenings applied if necessary, until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout of screening and water is seen squeezing out ahead of the roller.

Care shall be taken to see that the roadbase, sub-base or sub grade does not get damaged due to the addition of excessive water during construction.

Curing of the roadbase:

After final compaction of the roadbase, the road shall be allowed to dry overnight. Next morning 'hungry' spots shall be filled with screening materials as directed by the Supervising Engineer, lightly sprinkling water if necessary and rolled. No traffic shall be allowed on the road until the roadbase has set.

205.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range:

Vibrating Roller Minimum Weight	Number of Passes
Minimum 3 Tonne	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

205.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
205	250mm armoured gravel Road Base	Square metre

205.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Aggregate Armouring	
Los Angeles Abrasion Value	One per 1.0km (more frequently if material character changes*)*
Aggregate Water Absorption	As above
Natural Gravel	*As per RRST 201*

Site Testing

Gravel – as per RRST 201; armouring – visual inspection.

Armoured laterite:

TYPE OF TEST	FREQUENCY OF TEST
CBR (set of 3)	As above, on placed compacted material
Aggregate Armouring Gradation	One per 500m (more frequently if material character changes)*)*
Atterberg Limits	As above

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations.

Visual inspections will be made to check compliance with the drawings and specifications.

Shallow inspection pits shall be excavated through the completed roadbase on centre line and 0.5 metres from each edge of the road base every 0.5 km and to be properly reinstated, all as directed by the Supervising Engineer. Component layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 206

SAND SUB-BASE

206.1 DESCRIPTION

The work comprises providing, laying and compacting approved sand material to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer.

206.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Sub-base material shall be naturally occurring sand free from clay coating, organic debris and other deleterious materials and with a Sand Equivalent Value (SEV) of greater than 70. The following is the recommended grading envelope.

Sieve Size (mm)	% Passing (min – max)	
9.52	100	100
4.75	95	100
2.36	80	100
1.18	50	85
0.600	25	60
0.300	10	30
0.150	5	15
0.075	0	10

The sand shall have a minimum laboratory CBR of 30% at 95% modified AASHTO after 4 days soaking.

206.3 CONSTRUCTION METHODS

Prior to laying the sub-base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation to the satisfaction of the Supervising Engineer whose approval shall be obtained before sub-base works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed. Shoulder haunching to provide secure lateral support for the sub-base shall be in place prior to the construction of the sand sub-base layer.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any

depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

Material for the construction of the sub-base shall be dumped on the prepared formation in such a manner as to allow for continuity of operations over the length of the formation and to cause least inconvenience and danger to traffic.

Spreading of the material shall be by manual methods and shall be in such a manner as to allow the free flow of traffic through the works. The spreading shall be in layers not exceeding 175 mm loose thickness to form the final compacted thickness shown on the drawings.

Compaction shall be carried out in a series of continuous operations covering the full width and length of the layer concerned. The Supervising Engineer reserves the right to reduce the lengths of sections being treated at any time when he considers that the sections are too long to be compacted by the available equipment, or when specified compaction levels are not being achieved. The types of compaction equipment to be used and the number of passes to be made shall be such as to ensure the specified densities are being achieved without damaging the target layer or any underlying layer. Water should be added as necessary to facilitate compaction.

The target in-situ strength of the completed sand shall be not less than CBR 30% as measured by the Dynamic Cone Penetrometer (DCP) method at the specified compaction level of k=0.95 (Modified AASHTO).

The sand material shall, on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All extraneous matter, loose, segregated or otherwise defective areas shall be removed and made good with new material to the full thickness of the layer.

Component layer thickness tolerances to be -5 mm to +15 mm.

206.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range,

Vibrating Roller Weight	Number of Passes
Minimum 3 Tonne	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

206.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
206	150mm Sand Sub- Base	Square metre

206.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests undertaken at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution	One per 1km (more frequently if material character changes)
Sand Equivalent Value	As above
Atterberg Limits	As above
Modified AASHTO compaction	One per material source
4 Day Soaked CBR at 95% Modifed AASHTO	One per material source (more frequently if material character changes)

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
In situ strength by DCP (set of 3)	One per 1km or at change of material
In situ density	As above
Placed Compacted Material layer thickness	See following requirements

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations.

Visual inspection of sand sub-base operations and completed layer.

Shallow inspection pits shall be excavated through the completed sand sub-base layer on centre line and 0.5 metres from each edge of the sub-base every 1.0 km and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

Pavement layer quality and specification compliance inspections will be undertaken on all completed sections of the sand layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 207

QUARRY-RUN SUB-BASE

207.1 DESCRIPTION

The work comprises providing, laying and compacting approved quarry-run to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer.

207.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Quarry run material can be generally described as naturally occurring rock and weathered rock materials excavated from a quarry or borrow area and delivered to site without processing, apart from some selection or screening for the removal of oversize. For the purposes of the construction of rural road sub-base and shoulders the target for acceptable quarry run material will be to meet the established requirements for naturally occurring gravel used for the same purpose as defined in Tables 1 and 2 in 22 TCN 304-03.

Some latitude in grading and plasticity may be considered acceptable provided the required as-constructed strength is achieved, as follows:

4-day soaked CBR of 30% at 95% Modified AASHTO compaction.

207.3 CONSTRUCTION METHODS

Prior to laying the sub-base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation to the satisfaction of the Supervising Engineer whose approval shall be obtained before sub-base works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

Material for the construction of the sub-base shall be dumped on the prepared formation in such a manner as to allow for continuity of operations over the length of the formation and to cause least inconvenience and danger to traffic.

Spreading of the material shall be by manual or machine methods and shall be in such a manner as to allow the free flow of traffic through the works. The spreading shall be in layers each not exceeding 150 mm loose thickness to build up and form the final compacted thickness shown on the drawings.

Compaction shall be carried out and completed on each layer before the next loose layer is placed. Compaction shall be carried out in a series of continuous operations covering the full width and length of the layer concerned. Water should be added as necessary to facilitate compaction. The target in-situ strength of the compacted gravel layers shall be not less than CBR 30% for sub-base (at k=0.95 Modified AASHTO) as measured by the Dynamic Cone Penetrometer (DCP) method.

The quarry run material shall, on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All extraneous matter, loose, segregated or otherwise defective areas shall be removed and made good with new material to the full thickness of the layer.

Component layer thickness tolerances to be -5 mm to +15 mm.

207.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range:

Vibrating Roller Weight	Number of Passes
Minimum 3 Tonne	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

207.5 MEASUREMENT

The unit of measurement shall be cubic metres (m^3) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width, the instructed compacted thickness and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
207.1	Quarry-run Sub-Base	Cubic metre

207.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

TYPE OF TEST	FREQUENCY OF TEST
Modified AASHTO compaction	One per material source
4 Day Soaked CBR at 95% Modifed AASHTO	One per material source (more frequently if material character changes)
Particle Size Distribution	One per 1km (more frequently if material character changes)
Atterberg Limits	As above

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
In situ strength by DCP (set of 3)	3 per 1km or at change of material
In situ density	As above
Placed Compacted Material layer thickness	See below

DCP testing may be used as a control on quality once relationships between in situ density and DCP-CBR have been established in short trial or pilot sections at the beginning of operations

Visual inspections will be made to check compliance with the drawings and specifications.

The in-situ strength of the completed quarry run layers shall be not less than the specified CBR as measured by the Dynamic Cone Penetrometer (DCP) method.

Shallow inspection pits shall be excavated through the completed sub-base on centre line and 0.5 metres from each edge of the road base every 1.0 km and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 208

GRADED CRUSHED STONE SUB BASE & BASE

208.1 DESCRIPTION

The work comprises providing, laying, shaping and compaction of an approved graded crushed stone material to the Specification and to lines, levels, dimensions and crossfall as shown on the Engineering Drawings or as directed by the Supervising Engineer.

A surface seal would normally be applied to the road base as a separate specification item.

208.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Graded crushed stone

This is crushed fresh material that may include, quarried rock, natural granular material such as rocks, gravel or boulders. The materials may be separated by screening and then recombined to produce the required particle distribution if necessary. After crushing, the material should be angular in shape with a flakiness index of less than 35 percent. If the material resulting from crushing the stones does not have sufficient amount of fines, sand should be added.

The crushed material shall comply with the following requirements:

- Water absorption shall not exceed 2%.
- Los Angeles Abrasion (LAA) value not more than 35 or as directed by the Supervising Engineer.
- Shape, either TCVN 1772-87 =<35%, or 22TCN 57-84<10%
- Plasticity Index of binding materials shall not more than 6.

The materials shall be well graded and conform to the following grading limits:

Sieve size	Passing the sieve (% by mass)
	Nominal maximum particle size: 37.5 (mm)
50	100
37.5	80-100
20	60-90
10	40-70
5	30-55
2.36	20-45
0.425	8-30
0.075	5-15

208.3 CONSTRUCTION METHODS

Prior to laying the sub-base or road base, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation or sub-base all to the satisfaction of the Supervising Engineer whose approval shall be obtained before graded crushed stone roadbase works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-scarified and sufficient new material added to attain the correct shape.

Spreading of Aggregate

The broken aggregate shall be spread uniformly upon the sub-base layer in such quantities that the thickness of un-compacted layer is not over 200 mm. The loose layer is expected to be consolidated to about 66-75% thickness by compaction. Any segregation of the dumped material shall be reworked by labourers with hand tools. The surface of the aggregate shall be carefully finished with the aid of templates and levelling of all high or low spots by removing or adding aggregates as may be the case. The irregularities are much easier to correct in loose layer than later. The relationship between the loose thickness and compacted thickness shall be determined from field trials and used in controlling the loose thickness at the time of spreading the mixed materials. When placing (or grading), the moisture content of graded crushed stone shall be equal to or 1% higher than the optimum moisture content. If the moisture content is not satisfactory, during the placing (or grading) process, additional water should be added by using watering cans or tank or water spray bar set to secure light sprinkle application. Strong water application should not

be allowed so as to prevent washing off of fines. An even application of water should be ensured.

Rolling

Immediately following the spreading of aggregate, it is to be rolled with the aid of an approved vibratory roller. The rolling shall begin from edges with roller running forward and backward, parallel to the centreline of the road until the layer has been firmly compacted. Rolling shall continue until the material matrix is thoroughly keyed and stone creeping ahead of the roller in no longer visible. Light and even sprinkling of water may be required to assist compaction and to replace the evaporated water content. Rolling should not be done if the sub grade is soft or yielding. The rolled surface shall be checked transversely and longitudinally with templates and if the irregularities exceed 12 mm from the required plane, the surface should be loosened and aggregate added or removed before rolling again. In no case shall the use of screenings be permitted to make up depressions.

The target in-situ strength of the compacted layers shall be not less than CBR 30% for sub-base (at k=0.95 Modified AASHTO) and CBR 55% for base (at k=0.98 Modified AASHTO) as measured by the Dynamic Cone Penetrometer (DCP) method.

Care shall be taken to see that the sub-base or sub-grade does not get damaged due to the addition of excessive water during construction.

Curing of the roadbase

After final compaction of the sub-base or road base, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screening materials as directed by the Supervising Engineer, lightly sprinkling water if necessary and rolled. No traffic shall be allowed on the road until the sub-base or road base has set.

208.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range,

Vibrating Roller Weight	Number of Passes
Minimum 3 Tonne	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

208.5 MEASUREMENT

The unit of measurement shall be cubic metres (m^3) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width, the instructed compacted thickness and the measured length along the centre line of the road.

The rates shall include the supply, placing, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
208	Graded Crushed Stone Road base	Cubic metre

208.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

TYPE OF TEST	FREQUENCY OF TEST
Los Angeles Abrasion Value	One per 1.0km (more frequently if material character changes)
Aggregate Water Absorption	As above
CBR (set of 3)	As above, on placed compacted material
Mixed Material Gradation	One per 500m (more frequently if material character changes)
Mixed Material Atterberg Limits	As above
Layer Thickness	See 'Site Testing' below

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications.

Shallow inspection pits shall be excavated through the completed road base on centre line and 0.5 metres from each edge of the road base every 0.5 km and to be properly reinstated, all as directed by the Supervising Engineer. Component layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 209

SAND BEDDING LAYER

209.1 DESCRIPTION

Sand beds beneath selected pavement surfacings act as cushion and load transfer layer for the overlying construction. In some cases they act additionally as a drainage medium. Sand layers are required as a bedding medium beneath the following surfacings:

- Dressed stone setts – Specification RRST 304
- Fired clay bricks – Specification RRST 301
- Concrete bricks – Specification RRST 303
- Bamboo reinforced concrete – Specification RRST 401
- Steel reinforced concrete – Specification RRST 402
- Non-Reinforced concrete – Specification RRST 403

209.2 MATERIALS

The following paragraphs reference target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Bedding Sand

Bedding material shall be clean sharp sand free from clay coating, organic debris and other deleterious materials and with a Sand Equivalent Value (SEV) of greater than 70. The following is the recommended target grading envelope.

Sieve Size (mm)	% Passing (min – max)	
9.52	100	100
4.75	95	100
2.36	80	100
1.18	50	85
0.600	25	60
0.300	10	30
0.150	5	15
0.075	0	10

209.3 CONSTRUCTION METHODS

Prior to laying the bedding material, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation or sub-base to the satisfaction of the Supervising Engineer whose approval shall be obtained before sand bedding layer works commence.

All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish temporary screeding rails to ensure that the final shape of the layer confirms with the Drawings. Any edge restraints specified such as kerbs or shoulders should also be in place before construction of the sand bedding layer to ensure lateral restraint.

Sand materials shall be dumped on the prepared formation in such a manner as to allow for continuity of operations over the length of the formation. Traffic will be prevented from crossing the works until the bedding sand and any covering layer have been completed and/or cured ready for traffic. Alternative routes or detours will be arranged and maintained by the Contractor. If no reasonable detour can be arranged the Contractor will arrange for work to be carried out on half of the road width with alternate traffic flow on the other. The Contractor will arrange for traffic control during works and adequate signing at either end of the works for all periods.

Temporary screeding rails will be installed by the Contractor to control the thickness and profile of the sand layer. Spreading of the sand material shall be by manual methods to slightly above the screed levels. The sand will then be lightly compacted with one pass of a vibrating plate compactor or vibrating roller. Screeding boards will be used to remove the excess sand and level it to the correct profile giving a final thickness of 50mm, or as shown on the drawings.

209.4 CONSTRUCTION EQUIPMENT

The laid sand will be lightly compacted with either a 60kg plate compactor or 1,000kg vibrating roller.

Screeding rails and screeding boards shall be used at the edges of the pavement and centre line to ensure that the sand is spread to the correct thickness and profile.

209.5 MEASUREMENT

Sand bedding layers shall be measured by the cubic metres of sand placed and shaped on the road. The quantity of work will be calculated by multiplication of the actual screeded thickness implemented by the width and approved length of the road measured along the centre line of the road.

The rates shall include the supply, placing, spreading, compaction and shaping, as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
209	Sand Bedding Layer	Cubic metre

209.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests undertaken at more frequent intervals where quality of a material or work is in doubt

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Particle Size Distribution	One per 1km (more frequently if material character changes)
Sand Equivalent Value	As above

Site Testing

Visual inspection of screeds and screeding operations.

Shallow inspection pits shall be excavated through the completed bedding sand layer on centre line and 0.5 metres from each edge of the road base every 1.0 km and to be properly reinstated, all as directed by the Supervising Engineer. Layer thickness tolerances to be -5 mm to +15 mm.

Pavement layer quality and specification compliance inspections will be undertaken on all completed sections of the sand layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 210

DRY- BOUND MACADAM SUB-BASE & BASE

210.1 DESCRIPTION

The work comprises providing, laying and compacting dry bound macadam layers to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer.

Dry-bound macadam consists of a layer of broken or crushed stones of size up to 50mm, with finer, cohesionless material laid on top and vibrated into the voids, with minimal use of water.

210.2 MATERIALS

The following paragraphs reference target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Each layer of dry-bound macadam shall consist of a crushed or broken stone layer and a separate application of Blinding Fines.

Stone

This shall be machine crushed or manually broken fresh material that may include, quarried rock, natural granular material such as rocks, gravel or boulders. The material shall be single sized, separated by screening. After crushing/breaking, the material should be angular in shape meeting the following requirements:

Either:	TCVN 1772-87:	<35%
	or	
	22TCN 57-84	<10%

Plus :

Water absorption shall not exceed 2%.

Los Angeles Abrasion (LAA) value not more than 35 or as directed by the Supervising Engineer.

The crushed/broken stone materials shall conform to one of the following grading limits:

Test Sieve (mm)	Percentage by mass passing	
	M1	M2
75	100	-
50	85 – 100	100
37.5	35 – 70	85 – 100
28	0 – 15	0 – 40
20	0 - 10	0 - 5

The grading of M2 corresponds with a nominal 37.5mm single-sized aggregate and is appropriate for use with mechanically crushed aggregate. M1 is a broader nominal 50mm specification that can be used for manually-broken stone but if screens are available, M2, is preferred.

Blinding Fines

These should be clean, non-plastic, angular, well graded, crushed stone or natural sand passing the 5.0mm sieve:-

- Plasticity Index of binding materials shall be not more than 6.
- Fineness Modulus of sand fraction shall not be less than 1.80 and shall be free from deleterious materials.

210.3 CONSTRUCTION METHODS

Prior to laying the dry-bound macadam, the Contractor shall correct any deformations, ruts, soft spots or other defects in the formation or sub-base to the satisfaction of the Supervising Engineer whose approval shall be obtained before dry-bound macadam works commence. All drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of each pavement layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape. Any depressions in the surface shall be re-worked and sufficient new material added to attain the correct shape.

The dry-bound macadam process involves laying single-sized crushed/broken stone of either 37.5 mm or 50mm nominal size in a series of layers to achieve the design thickness. The compacted thickness of each layer should not exceed twice the nominal stone size. Each layer of coarse aggregate shall be placed, raked and shaped and then compacted into an interlocked condition with a an approved static roller (or vibrating roller with vibration switched off).

The approved well graded fine aggregate, passing the 5.0mm sieve, shall then be spread onto the surface, and rolled into the voids with a vibrating roller to produce a dense layer. Compaction shall be carried out in a series of continuous operations covering the full width and length of the layer concerned.

Any loose material remaining is brushed off and final compaction carried out. The sequence is then repeated until the design thickness is achieved.

The blinding fines may need to be lightly watered to assist in the process. However, care is necessary in this operation to ensure that any water sensitive plastic materials in the sub-base or sub-grade do not become saturated. The compacted thickness of each layer should not exceed twice the maximum size of the stone.

The dry-bound macadam shall, on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All extraneous matter, loose, segregated or otherwise defective areas shall be removed and made good with new material to the full thickness of the layer.

The target in-situ strength and density of the compacted dry-bound macadam layers shall be not less than CBR 30% for sub-base (at k=0.95 Modified AASHTO) and CBR 55% for base (at k=0.98 Modified AASHTO) as measured by in-situ CBR apparatus.

Component layer thickness tolerances to be -5 mm to +15 mm.

210.4 CONSTRUCTION EQUIPMENT

The minimum compactive effort per rolling per constructed layer shall be in the range:

Rollers Minimum Weight	Number of Passes
6Tonne Static Roller	Until aggregate locked
3Tonne Vibrating Roller	6-8 per point

The type and condition of the compaction equipment shall be approved by the Supervising Engineer and the number of passes confirmed by correlation with achieved strength and density in trial sections at the beginning of operations.

210.5 MEASUREMENT

The unit of measurement shall be cubic metres (m^3) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width, thickness and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
210	Dry-bound macadam Road Base	Cubic metre

210.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

TYPE OF TEST	FREQUENCY OF TEST
Los Angeles Abrasion Value	One per 1.0km (more frequently if material character changes)
Aggregate Water Absorption	As above
Component Material Gradation	One per 500m for coarse aggregate and blinding fines (more frequently if material character changes)
Component Material Atterberg Limits	As above
Aggregate Flakiness	As above
In situ CBR at 95% or 98% Modifed AASHTO as required	As above
In situ Density	As above

Laboratory Testing

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Where testing facilities are not conveniently available, the Contractor shall submit samples to the Supervising Engineer for approval.

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications.

Shallow inspection pits shall be excavated through the completed roadbase on centre line and 0.5 metres from each edge of the road base every 0.5 km and to be properly reinstated, all as directed by the Supervising Engineer. Component layer thickness tolerances to be -5 mm to +15 mm.

DRAFT SPECIFICATION RRST 301

FIRED CLAY BRICK PAVEMENT – UNMORTARED JOINTS

301.1 DESCRIPTION

The work comprises providing, laying and placing a layer of on-edge bricks within edge restraints on each side of the pavement to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer. The bricks are laid in a herring bone or other approved pattern on a sand bedding layer as indicated on the Engineering Drawings. Joints between the bricks are in-filled with suitable sand. A seal may be specified to be used to waterproof the finished surface as a separate operation.

301.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Fired Clay Bricks

The raw material for brick manufacture should be a sandy clayey silt or silty clay of low to medium plasticity. The material should be uniform and comprise a relatively high proportion of silica (quartz) minerals. It must also be free from significant quantities of deleterious materials such as combustible vegetable matter, mica minerals and salts.

The fired bricks shall be of engineering standard with the following characteristics:-

Dimensions:	200x100x70mm (or as agreed by the Supervising Engineer)
Dimensional Tolerance:	+/- 3%
Water absorption:	<16% of their weight of water after 1 hour soaking
Unit weight:	>1200 kg/m3
Crushing strength:	>20MPa (as determined by TCVN 6355-5-98)

The bricks shall be solid, regular and uniform in shape and texture with sharp square edges and parallel faces. They shall be free from flaws, chips, stones and blemishes and shall emit a clear metallic ring when struck against each other.

Joint Fill Material

Material for joint in-filling shall be clean sharp sand free from clay coating, organic debris and other deleterious materials. It shall have a Fines Modulus not less than 0.8 and a Sand Equivalent Value of greater then 70.

301.3 CONSTRUCTION METHODS

Prior to laying the brick paving, all drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of the brick layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape.

Delivered bricks shall be stacked on or adjacent to the prepared formation in such a manner as to allow for continuity of operations, avoid damage to the bricks and to cause least inconvenience and danger to traffic.

The bricks shall be laid on edge (100mm depth) over a compacted and screeded bedding layer (Specification RRST 209) within edge restraints, as detailed on the Engineering Drawings and as required by the Supervising Engineer's Representative. The bricks should be laid in a herring bone or other approved pattern. Joint width between bricks shall be between 5 and 10mm.

Filling sand shall be spread over the placed bricks, and brushed into the joints. The laid paving will then be compacted with a vibrating plate compactor to properly bed the bricks and key the joint sand securely between the bricks. Joints shall be refilled as necessary to achieve full joints and satisfactory interlock between the bricks.

All extraneous matter, or defective bricks shall be removed and made good with new material to the full thickness of the layer.

.

301.4 CONSTRUCTION EQUIPMENT

60 kg Vibrating plate compactor

301.5 MEASUREMENT

Un-mortared brick surfacing shall be measured by the square metres of placed and interlocked brick layering on the road. The quantity for which payment shall be made shall be the product of the instructed average width (including edge restraints/kerbs) and the measured length along the centre line of the road.

The rates shall include the placing, shaping, watering and interlocking, including edge constraints, as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
301	Fired Clay Brick Pavement – Un-Mortared Joints	Square metre

301.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals, where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Density of bricks	2 sets of 5 per material source (more frequently if material character changes) and one per km of road
Compressive strength of bricks	As above
Water Absorption of the bricks	As above
Particle size distribution of joint sand	As above
Sand Equivalence test on joint sand	As above

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
Dimensional tolerance of bricks	Sample of 10 from each 1km,

Visual inspections will be made to check compliance with the drawings and specifications.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the brick layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 302

FIRED CLAY BRICK PAVEMENT – MORTARED JOINTS

302.1 DESCRIPTION

The work comprises providing, laying and placing a layer of on-edge bricks within edge restraints on each side of the pavement to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer. The bricks are laid on a thin layer of cement mortar in a herring bone or other approved pattern as indicated on the Engineering Drawings. Joints between the bricks are in-filled with cement mortar.

302.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Fired Clay Bricks

The raw material for brick manufacture should be a sandy clayey silt or silty clay of low to medium plasticity. The material should be uniform and comprise a relatively high proportion of silica (quartz) minerals. It must also be free from significant quantities of deleterious materials such as combustible vegetable matter, mica minerals and salts.

The fired bricks shall be of engineering standard with the following characteristics:-

Dimensions:	200x100x70mm (or as agreed by the Supervising Engineer)
Dimensional Tolerance:	+/- 3%
Water absorption:	<16% of their weight of water after 1 hour soaking
Unit weight:	>1200 kg/m3
Crushing strength:	>20MPa (as determined by TCVN 6355-5-98)

The bricks shall be solid, regular and uniform in shape and texture with sharp square edges and parallel faces. They shall be free from flaws, chips, stones and blemishes and shall emit a clear metallic ring when struck against each other.

Bedding and Joint Fill Material

Material for the bedding and joint in-filling shall be a cement mortar Grade 75 (fine sand).

302.3 CONSTRUCTION METHODS

Prior to laying the brick paving, all drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of the brick layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape.

Delivered bricks shall be stacked on or adjacent to the prepared formation in such a manner as to allow for continuity of operations, avoid damage to the bricks and to cause least inconvenience and danger to traffic.

The bricks shall be laid on edge (100mm depth) on a 20mm cement mortar bed on the pre-prepared and approved roadbase within edge restraints, as detailed on the Engineering Drawings and as required by the Supervising Engineer's Representative. Joint width between bricks shall be between 5 and 10mm.

.

Joints shall be filled as necessary with cement mortar to achieve satisfactory interlock between the bricks. Joints will be finished level with the top face of the bricks to provide a smooth finished surface.

All extraneous matter, or defective bricks shall be removed and made good with new material to the full thickness of the layer.

After the mortar has set, the mortared brick paving will be cured for a period of 7 days by keeping the surface damp with water. After 14 days the surface may be opened to traffic.

.

302.4 CONSTRUCTION EQUIPMENT

Cement mortar will be mixed with a suitable concrete mixer of at least 80 litre mix capacity.

302.5 MEASUREMENT

Mortared clay brick surfacing shall be measured by the square metres of placed and mortared brick layering on the road. The quantity for which payment shall be made shall be the product of the instructed average width (including edge restraints/kerbs) and the measured length along the centre line of the road.

The rates shall include the supply, placing, tamping and mortaring of the clay brick surfacing including edge constraints, as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
302	Fired Clay Brick Pavement – Mortared Joints	Square metre

302.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals, where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Density of bricks	2 sets of 5 per material source (more frequently if material character changes)) and one per km of road
Compressive strength of bricks	As above
Water Absorption of the bricks	As above

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
Dimensional tolerance of bricks	Sample of 10 from each 1km,

Visual inspections will be made to check compliance with the drawings and specifications.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the brick layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 303

CEMENT CONCRETE BRICK PAVEMENT

303.1 DESCRIPTION

This activity comprises 80mm thick rectangular concrete bricks being laid in a herringbone or other approved pattern to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer and within confining edge-kerbs on each side of the pavement. They are compacted into place, with sand brushed-in at the joints.

A seal may be specified to be used to waterproof the finished surface as a separate operation.

303.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Concrete Bricks

Concrete bricks 200x100x80mm thick should be used composed of concrete with a minimum 28 day cube strength of 25MPa. Maximum aggregate size is 6mm. Bricks should be cured for 28 days. The bricks shall be regular and uniform in shape and texture with sharp square edges and parallel faces. They shall be free from flaws, and blemishes. Dimensional Tolerance on brick dimensions is to be +/- 3%. The bricks may have a bevel on the top edges.

Kerbs

Kerbs should be cast-in-place using concrete with a minimum cube strength of 25Mpa. Alternative kerb edging may be specified on the drawings.

Joint Fill Material

Material for joint in-filling shall be clean sharp sand free from clay coating, organic debris and other deleterious materials. It shall have a Fines Modulus not less than 0.8 and a Sand Equivalent Value of greater than 70.

303.3 CONSTRUCTION METHODS

Prior to laying the brick paving, all drainage works necessary to keep the road formation and pavement layers free of standing water should be completed.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of the brick layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape.

Delivered bricks shall be stacked on or adjacent to the prepared formation in such a manner as to allow for continuity of operations, avoid damage to the bricks and to cause least inconvenience and danger to traffic.

The bricks shall be laid in a herringbone or other approved pattern over a bedding layer (Specification RRST 209) within prepared kerbs, as detailed on the engineering drawings and as required by the Supervising Engineer's Representative. Joints between bricks shall not exceed 10mm.

Filling sand shall be spread over the placed bricks, and brushed into the joints. The laid paving will then be compacted with a vibrating plate compactor to properly bed the bricks and key the joint sand securely between the bricks. Joints shall be refilled as necessary to achieve full joints and satisfactory interlock between the bricks.

All extraneous matter, or defective bricks shall be removed and made good with new material to the full thickness of the layer.

303.4 CONSTRUCTION EQUIPMENT

60 kg Vibrating plate compactor

303.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of placed and compacted material. The quantity for which payment shall be made shall be the product of the instructed average width (including edge restraints/kerbs) and the measured length along the centre line of the road.

The rates shall include the placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
303	80mm Concrete Brick Pavement	Square metre

303.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the

frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals, where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Compressive strength of concrete bricks	One set of 3 per material source (more frequently if material character changes)
Particle size distribution of joint sand	One test per material source (more frequently if material character changes) and one test per km of road
Sand Equivalence test on joint sand	As above

Site Testing

TYPE OF TEST	FREQUENCY OF TEST
Dimensional tolerance of bricks	Sample of 10 from each 1km,

Visual inspections will be made to check compliance with the drawings and specifications.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the brick layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 304

MORTARED DRESSED STONE SURFACING

304.1 DESCRIPTION

This activity comprises 150-200mm thick dressed stones being laid to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer. Dressed stones will be laid between edge restraints and compacted into a sand bedding layer (Specification RRST209), followed by cement mortaring of the joints.

304.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Dressed Stones

The parent material for the dressed stones should be a strong, homogenous, isotropic rock, free from significant discontinuities such as cavities, joints, faults and bedding planes. It should be in a fresh condition free from deleterious inclusions, and not susceptible to weathering, degradation or significant strength deterioration on exposure. Experience indicates that igneous rocks such as fresh granite and basalt can be suitable materials.

The rock should have the following mechanical properties:

- Uni-axial compressive strength: >75MPa
- Los Angeles Abrasion value: <25%
- Sodium Sulphate Soundness: <10% loss

The dressed stones shall be for example 300mm x 200mm x 100mm in size (or other dimensions approved by the Supervising Engineer) and shall be regular and uniform in shape and texture with sharp square edges and parallel faces. They shall normally be hand cut from solid rock and trimmed (dressed) if necessary to form a regular cubic shape, free from flaws and discontinuities. The top (surface) face shall be reasonably smooth. The distance between a 30cm straight edge placed across any orientation on the top face and the sett top surface must not be more than 5mm; this criteria applies to any point on the top face more than 20mm from the edge of the stone.

Mortar

Cement mortar for bedding and joints shall be Grade 75 (fine sand).

304.3 CONSTRUCTION METHODS

Delivered dressed stones shall be stacked on, or adjacent to, the prepared formation in such a manner as to allow for continuity of operations, avoid damage to the stones and to cause least inconvenience and danger to traffic.

Dressed stones should be laid on a previously prepared sand bedding layer. The pavement edge stones or kerbs shall be placed first to act as a level and alignment guide for the rest of the paving. All stones will be placed with the longest dimension across the road and thickness between 150 – 200 mm as shown on the drawings. Alternate stones at the pavement edge will be half size to allow joints in the paving to be staggered in adjacent rows (stretcher bond). The edge stones will be bedded and jointed with cement mortar.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of the stone sett layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape.

Each dressed stone should be lightly tapped into position with a mason's hammer, to ensure initial bedding. Joints between stones should be a nominal 10mm wide, but may vary up to 20mm due to variations in the stone faces, and part filled with cement mortar. When a small area of setts is in place they should be consolidated in position with a small hand-operated plate compactor. The joints should then be filled and consolidated to within 5mm of the surface with cement mortar, and finished smoothly. The resulting slight joint depression will assist surface drainage.

All extraneous matter, or damaged stones shall be removed and made good with new material to the full thickness of the layer.

Once the mortar has set, the paving shall be cured by spreading sand or sacking over the surface of the pavement and repeatedly wetting the materials for a period of at least 7 days. The Supervising Engineer may direct a longer curing period depending on local circumstances. No traffic shall be allowed on the pavement until a period of 14 days has elapsed. Suitable temporary diversions should be made for continued flow of normal traffic.

304.4 CONSTRUCTION EQUIPMENT

Concrete mixer of at least 80 litre mix capacity

Compaction shall be provided by a 60 kg vibrating plate compactor.

304.5 MEASUREMENT

Mortared dressed stone surfacing shall be measured by the square metres of placed and interlocked stone layering on the road of the specified thickness. The quantity of work will be calculated by measurement of the width (including edge stones) and approved length of the paving, measured along the centre line of the road.

The rates shall include the supply, placing, tamping and mortaring of the dressed stone surfacing including kerb constraints, as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
304	Dressed Stone Surfacing of specified thickness (between 150 and 200mm)	Square metre

304.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests undertaken at more frequent intervals, where quality of a material or work is in doubt.

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Los Angeles Abrasion Value	One per 1.0km (more frequently if material character changes)
Uni-axial compressive strength	As above
Sodium Sulphate Soundness	As above

Site Testing

Visual Inspection of operations will be made to check compliance with the drawings and specifications.

Dimensional regularity of stones. Tolerance on stone thickness variation ±15mm. Upper face of individual setts maximum 5mm surface depression from a 30cm straight edge laid across the face at any point more than 20mm from the edge of the sett. Maximum clearance to a 2 metre straight edge laid at any orientation across the pavement to be 10mm at any point more than 20mm from the edge of the sett.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the stone paving layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 305
COBBLE STONE PAVED SURFACING

305.1 DESCRIPTION

This activity comprises roughly cubic selected cobble stones of 100-150mm being laid to lines, levels and dimensions as shown on the Engineering Drawings and as directed by the Supervising Engineer. The cobble stones will be laid between edge restraints and compacted into a sand bedding layer (Specification Clause 209). This is followed by brushing and vibrating-in of coarse sand to fine gravel sized material into the spaces between stones.

305.2 MATERIALS

The following paragraphs define target specifications for natural materials that should be used in the construction of this pavement layer. In the event that appropriate material cannot be reasonably obtained then the Contractor may submit alternative materials to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Cobble Stones

The parent material for the cobble stones should be a strong, homogenous, isotropic rock, free from significant discontinuities such as cavities, joints, faults and bedding planes. It should be in a fresh condition free from deleterious inclusions, and not susceptible to weathering, degradation or significant strength deterioration on exposure. Experience indicates that rocks such as fresh granite, basalt and crystalline limestone can be suitable materials.

The rock should have the following mechanical properties:

- Uni-axial compressive strength >75MPa
- Los Angeles Abrasion value: <25%
- Sodium Sulphate Soundness <10% loss

Cobble stones should be roughly cubic in shape with a thickness in the range 100-150mm. The individual cobble stones should have at least one face that is reasonably flat and suitable to be the upper surface.

Sand-Gravel Infill

The material infilling the spaces between the stones should be loose, dry natural or crushed stone material with a grading equivalent to a well graded coarse sand to fine gravel. The material shall be clean and free from clay coating, organic debris and other deleterious materials.

305.3 CONSTRUCTION METHODS

Cobble stones should be laid on a previously prepared loose laid sand bedding layer. Cement mortar bedded and jointed pavement edge stones or kerbs shall be placed

first to act as an edge restraint and a level and alignment guide for the rest of the paving. All cobble stones will be placed with the smoothest face uppermost and preferably with the largest dimension across the road. Stones will be selected and placed to form transverse rows of stones of similar dimension parallel to the road centre line.

Each stone should be lightly tapped into position with a mason's hammer, to ensure initial bedding. String-lines shall be used as a guide for finished crossfall and level of the surface and row alignment. Spaces between stones should not generally exceed 10mm. These spaces should be infilled by brushing in the specified sand-gravel material. When a small area of stones is in place they should be consolidated in position with a small vibrating roller or plate compactor. Additional infill materials should be brushed into the surface as required. Final rolling shall be carried out by a minimum1 Tonne vibrating roller with 6-8 passes per point. Light and even sprinkling of water may be used to aid compaction.

.

The Contractor shall establish sufficient setting out pegs and string lines to ensure that the final shape of the cobble stone layer confirms with the Drawings, which shall be checked with a camber board, or straight edge, spirit level and tape.

Delivered cobble stones shall be stacked on, or adjacent to, the prepared formation in such a manner as to allow for continuity of operations, avoid damage to the cobble stones and to cause least inconvenience and danger to traffic.

All extraneous matter, or damaged cobbles shall be removed and made good with new material to the full thickness of the layer.

Maximum clearance to a 2 metre straight edge laid at any orientation across the pavement to be 10mm to the centre of a cobble stone at any point.

305.4 CONSTRUCTION EQUIPMENT

Compaction - minimum 1 Tonne vibrating roller with 6-8 passes per point.

Tamping - Plate Compactor

305.5 MEASUREMENT

Cobble stone surfacing shall be measured by the square metres of placed and interlocked stone layering on the road. The quantity of work will be calculated by measurement of the width (including edge restraints/kerbs) and approved length of the road, measured along the centre line of the road, taking into account the depth of the compacted layer.

The rates shall include the supply, placing, tamping and compaction of the cobble stone surfacing including kerb restraints, as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
305	Cobble Stone Surfacing	Square metre

305.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum, and the Supervising Engineer shall have the authority to have these tests undertaken at more frequent intervals, where quality of a material or work is in doubt.

Materials from each source should be submitted to the Supervising Engineer for approval in advance of the commencement of work.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Los Angeles Abrasion Value of Cobble	One per 1.0km, with a minimum of one per constructed length (more frequently if material character changes)
Uni-axial compressive strength of Cobble	As above
Sodium Sulphate Soundness of Cobble	As above
Particle Size distribution of infill	As above

Site Testing

Visual Inspection of operations will be made to check compliance with the drawings and specifications.

Upper face of individual stones shall be generally smooth and checked by 2 metre straight edge for overall paving surface variation.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the stone paving layer by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 401

BAMBOO REINFORCED CONCRETE PAVEMENT (BRC)

401.1 DESCRIPTION

The work comprises providing materials for and constructing bamboo reinforced Portland cement concrete slabs, together with associated load transferring dowels and joint sealing materials, laid to lines, levels and dimensions, as shown on the Engineering Drawings and as directed by the Supervising Engineer.

401.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Bamboo

Only adult bamboo of age 3 or 4 years growth should be used. Bamboo should be cut, allowed to dry and season for a minimum of 4 weeks and up to 6 weeks before use. The bamboo for reinforcement shall be in a split form (splints), produced after proper seasoning. Bamboo should be split into reasonably straight splints approximately 20 - 25mm wide. Bamboo splitting should be undertaken by separating the base with a sharp blade and then pulling a blunt blade through the culm, thus producing nearly straight section splints with continuous fibres.

The Supervising Engineer may specify treatment to prevent decay and minimise its capacity to absorb water. Bamboo should be stored under cover to protect it from rain and clear of the ground (20 or 30cm). Good ventilation and frequent inspection are necessary.

Concrete

Concrete shall be Grade 200 and have a minimum compressive strength of 20Mpa (28 days) with a guidance water/cement ratio of 0.45. Concrete mix proportions should be calculated to suit the available materials in order to meet the required compressive strength and slump requirements The use of low water-cement ratios (e.g. 0.45), higher cement contents, plasticiser and high early-strength cement is beneficial in minimising the risk of cracks. Concrete shall otherwise be constructed to the requirements of current Vietnamese Standards.

Concrete Aggregate

Concrete aggregates shall conform to the current Vietnam Standards applicable to crushed stone aggregate for rural roads (TCVN 1771: 1987; TCVN 1772:1987). No uncrushed rounded coarse natural aggregate shall be permitted.

Load Transfer Dowels

Load transfer dowels shall be provided at each joint between slabs. They shall be made with 14 mm diameter mild steel reinforcing bars, 500mm in length. The steel shall comply with current Vietnam Standards for concrete reinforcement.

401.3 CONSTRUCTION METHODS

BRC pavement shall be constructed on a previously prepared sand bedding layer (Specification RRST 209) that has been examined and accepted by the Supervising Engineer's Representative. An impervious plastic membrane may be placed on top of the prepared sand bedding layer prior to concrete placement to inhibit moisture loss from the concrete. If a membrane is not employed then the sand bedding layer must in soaked, compacted and undisturbed state immediately prior to concrete pavement placement.

Bamboo Reinforcement Mesh

The approved bamboo culms shall be formed into mesh grid with 200mmx200mm spacing, comprising splints measuring 25mm in width on average, as detailed on the Engineering Drawings. Each intersection of the bamboo grid is to be secured with steel binding wire. Bamboo reinforcements may be spliced, either by providing an overlap of 16 times the splint width, or using suitable mechanical devices. Splices should be staggered and not located at sections of high stress.

Bamboo mesh should be placed at the top 1/3 of the concrete slab, with minimum concrete cover on the bamboo reinforcement at any point of 50mm. The reinforcing grid should be positioned on, and secured to, solid brick or concrete spacers to ensure the correct height.

Bamboo should be placed with its concave face upwards. The basal and distal ends of the bamboo must be alternated in the mesh so that a uniform reinforcing area is obtained along the length and breadth of the slab.

Precautions should be taken to counter the tendency of the bamboo mesh to float during casting by ensuring a suitable water-cement ratio.

Joints

Contraction joints of 10mm width are to be provided at 5m intervals in the pavement, to relieve tensile stresses. Expansion joints are to be provided at 250m intervals. All joints are to be filled and sealed with a mixture of sand and bitumen, with a reservoir of bitumen provided at the top of each joint. All joints are to be provided with load transfer steel dowels.

14mm diameter mild steel reinforcing bars of 500mm length are to be placed at 250mm centres at all expansion and contraction joints.

At expansion joints the dowel bar should be anchored into the concrete at one end and the other end coated with bitumen and fitted into a PVC sleeve. The PVC tube is omitted at contraction joints.

Concrete slabs should normally be constructed at full carriageway width. In some circumstances (e.g. to allow traffic flow in difficult terrain) construction of half-width concrete slabs may be permitted, but only with the agreement of the Supervising

Engineer. Longitudinal joints should have a load transferring dowel and sealing arrangement similar to that of transverse contraction joints. In low volume roads (Commune Class B) it may be permissible to use profiled formwork to produce a "tongue in groove" load transferring arrangement for longitudinal joints in place of dowels.

Concrete

All concrete shall be mixed on site in small capacity batch mixers complying with the appropriate Vietnamese Standards. Mixers with a capacity less than one bag of cement shall not be used and no mixer shall be charged in excess of its rated capacity. Cement shall be fresh and stored in a clean dry location. Aggregates shall be stored separately in a clean area. Proportions of aggregates shall be measured using weighing apparatus or batching boxes. Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste. Water proportions shall be determined using containers of known volume.

All formwork shall be well secured and free from defects or gaps, and able to resist the tamping forces. The top edge of the formwork shall be within ± 2mm of the required finished road levels. Prior to placing the concrete, all formwork and reinforcement shall be thoroughly inspected and passed by the Supervising Engineer's Representative. All wood chips, dust, sand, construction debris and any other deleterious material shall be removed from the formwork and reinforcement prior to placing the concrete. All formwork shall be wetted to ensure it is damp when the concrete is poured. Care should be taken during this operation such that pools of excess water do not form in the base of the formwork and also that the bamboo mesh is not wetted.

Temporary planking walkways shall be provided to allow the concrete to be barrowed to the location of placement without disturbing the reinforcement mesh.

Once the concrete had been placed uniformly within the forms, compaction shall be carried out using a mechanical poker vibrator. Care should be taken to ensure a good bond between layers of fresh concrete placed separately by vibrating the two layers together until a satisfactorily homogenous cross section is obtained.

No concrete shall be compacted after initial setting has commenced. All concrete shall be compacted until no air bubbles appear on the surface of the fresh concrete. Care shall be taken not to touch the formwork or embedded reinforcement with the vibrator since this would result in concrete having begun initial setting being exposed to re-vibration. It could also have a detrimental effect on the bond between the concrete matrix and the bamboo reinforcement.

After placement and compaction, the camber shall be shaped in the fresh concrete to lines and levels detailed in the Engineering Drawings. In order to improve the skid-resistance of the surface and to minimise the vehicles' breaking distance, transverse grooves shall be etched in the fresh concrete surface utilising an appropriate rake.

The concrete shall be cured by spreading sand or sacking over the surface of the pavement and repeatedly wetting the materials for a period of at least 7 days. The Supervising Engineer may direct a longer curing period depending on local circumstances. No traffic shall be allowed on the pavement until a period of 14 days has elapsed. Suitable temporary diversions should be made for continued flow of normal traffic.

Concrete shall not be mixed or poured when ambient shade temperatures are less than 4 degrees Celsius or more than 38 degrees Celsius.

401.4 CONSTRUCTION EQUIPMENT

The following equipment, apparatus and special hand-tools shall be used:

- Formwork
- Concrete mixer of at least 250 litre capacity
- Batching boxes or weighing apparatus
- Wheelbarrows
- Vibrating poker powered by electricity or portable generator
- Tamping screed
- Portable sun protection canopy if casting in direct sunlight if ambient shade temperatures are above 25 degrees Celsius
- Grooving rake

401.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of constructed bamboo reinforced concrete. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, formwork, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
401	150mm Bamboo Reinforced Concrete	Square metre

401.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the

frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Aggregate properties as defined in relevant Vietnamese Standards	One set per 1km (more frequently if material character changes)
Concrete cube strength	One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days for mix design per materials source. One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days per 500m of pavement

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications:

- bedding sand
- bamboo mesh
- dowels
- formwork
- aggregate
- water
- concrete placing and finish

A Slump Test will be carried out on every concrete batching shift, or as directed by the Supervising Engineer. The slump shall be 40 - 60mm with membrane) or 60-80mm (without membrane). Concrete exceeding these criteria will be rejected.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the BRC pavement by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 402

STEEL REINFORCED CONCRETE PAVEMENT (SRC)

402.1 DESCRIPTION

The work comprises providing materials for and constructing steel reinforced Portland cement concrete slabs, together with associated load transferring dowels and joint sealing materials, laid to lines, levels and dimensions, as shown on the Engineering Drawings and as directed by the Supervising Engineer.

402.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Reinforcement

Reinforcement shall be mild steel mesh or round bars complying with current Vietnamese Standards for concrete reinforcement. The grid shall be 6mm diameter mesh/rods at 200mm centres.

Concrete

Concrete shall be Grade 200 and have a minimum compressive strength of 20Mpa (28 days) with a guidance water/cement ratio of 0.45. Concrete mix proportions should be calculated to suit the available materials in order to meet the required compressive strength and slump requirements The use of low water-cement ratios (e.g. 0.45), higher cement contents, plasticiser and high early-strength cement is beneficial in minimising the risk of cracks. Concrete shall otherwise be constructed to the requirements of current Vietnamese Standards.

Concrete Aggregate

Concrete aggregates shall conform to the current Vietnam Standards applicable to crushed stone aggregate for rural roads (TCVN 1771: 1987; TCVN 1772:1987). No uncrushed rounded coarse natural aggregate shall be permitted.

Load Transfer Dowels

Load transfer dowels shall be provided at each joint between slabs. They shall be made with 14 mm diameter mild steel reinforcing bars, 500mm in length. The steel shall comply with current Vietnamese Standards related to concrete reinforcement

402.3 CONSTRUCTION METHODS

SRC pavement shall be constructed on a previously prepared sand bedding layer (Specification RRST 209) that has been examined and accepted by the Supervising Engineer's Representative. A impervious plastic membrane may be placed on top of the prepared sand bedding layer prior to concrete placement to inhibit moisture loss from the concrete. If a membrane is not employed then the sand bedding layer must

in soaked, compacted and undisturbed state immediately prior to concrete pavement placement.

Reinforcement

The reinforcing steel mesh should be placed at the top 1/3 of the concrete slab with minimum concrete cover on the steel reinforcement at any point of 50mm. The mesh grid is to have dimensions of 200mmx200mm, as detailed on the Engineering Drawings. If the mesh is formed of reinforcing rods, they are to be secured with steel binding wire. The reinforcing grid is to be positioned on, and secured to, solid brick or concrete spacers to ensure the correct height.

Joints

Contraction joints of 10mm width are to be provided at 5m intervals in the pavement, to relieve tensile stresses. Expansion joints are to be provided at 250m intervals. All joints are to be filled and sealed with a mixture of sand and bitumen, with a reservoir of bitumen provided at the top of each joint. All joints are to be provided with load transfer steel dowels.

14 mm diameter mild steel reinforcing bars of 500mm length are to be placed at 250mm centres at all expansion and contraction joints.

At expansion joints the dowel bar should be anchored into the concrete at one end and the other end coated with bitumen and fitted into a PVC sleeve. The PVC tube is omitted at contraction joints.

Concrete slabs should normally be constructed at full carriageway width. In some circumstances (e.g. to allow traffic flow in difficult terrain) construction of half-width concrete slabs may be permitted, but only with the agreement of the Supervising Engineer. Longitudinal joints should have a load transferring dowel and sealing arrangement similar to that of transverse contraction joints. In low volume roads (Commune Class B) it may be permissible to use profiled formwork to produce a “tongue in groove” load transferring arrangement for longitudinal joints in place of dowels.

Concrete

All concrete shall be mixed on site in small capacity batch mixers complying with the appropriate Vietnamese Standards. Mixers with a capacity less than one bag of cement shall not be used and no mixer shall be charged in excess of its rated capacity. Cement shall be fresh and stored in a clean dry location. Aggregates shall be stored separately in a clean area. Proportions of aggregates shall be measured using weighing apparatus or batching boxes. Water should be fresh not brackish (total salt content <3000mg/litre) and not contaminated by industrial or other waste. Water proportions shall be determined using containers of known volume.

All formwork shall be well secured and free from defects or gaps, and able to resist the tamping forces. The top edge of the formwork shall be within ± 2mm of the required finished road levels. Prior to placing the concrete, all formwork and reinforcement shall be thoroughly inspected and passed by the Supervising Engineer’s Representative. All wood chips, dust, sand, construction debris and any other deleterious material shall be removed from the formwork and reinforcement prior to placing the concrete. All formwork shall be wetted to ensure it is damp when the concrete is poured. Care should be taken during this operation such that pools of excess water do not form in the base of the formwork.

Temporary planking walkways shall be provided to allow the concrete to be barrowed to the location of placement without disturbing the reinforcement mesh.

Once the concrete had been placed uniformly within the forms, compaction shall be carried out using a mechanical poker vibrator. Care should be taken to ensure a good bond between layers of fresh concrete placed separately by vibrating the two layers together until a satisfactorily homogenous cross section is obtained.

No concrete shall be compacted after initial setting has commenced. All concrete shall be compacted until no air bubbles appear on the surface of the fresh concrete. Care shall be taken not to touch the formwork or embedded reinforcement with the vibrator since this would result in concrete having begun initial setting being exposed to re-vibration. It could also have a detrimental effect on the bond between the concrete matrix and the steel reinforcement.

After placement and compaction, the camber shall be shaped in the fresh concrete to lines and levels detailed in the Engineering Drawings. In order to improve the skid-resistance of the surface and to mimimise the vehicles' breaking distance, transverse grooves shall be etched in the fresh concrete surface utilising an appropriate rake.

The concrete shall be cured by spreading sand or sacking over the surface of the pavement and repeatedly wetting the materials for a period of at least 7 days. The Supervising Engineer may direct a longer curing period depending on local circumstances. No traffic shall be allowed on the pavement until a period of 14 days has elapsed. Suitable temporary diversions should be made for continued flow of normal traffic.

Concrete shall not be mixed or poured when ambient shade temperatures are less than 4 degrees Celsius or more than 38 degrees Celsius.

402.4 CONSTRUCTION EQUIPMENT

The following equipment, apparatus and special handtools shall be used:

- Formwork
- Concrete mixer of at least 250 litre capacity
- Batching boxes or weighing apparatus
- Wheelbarrows
- Vibrating poker powered by electricity or portable generator
- Tamping screed
- Portable sun protection canopy if casting in direct sunlight if ambient shade temperatures are above 25 degrees Celsius
- Grooving rake

402.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of constructed steel reinforced concrete. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, formwork, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
402	150mm Steel Reinforced Concrete	Square metre

402.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Aggregate properties as defined in relevant Vietnamese Standards	One set per 1km (more frequently if material character changes)
Concrete cube strength	One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days for mix design per materials source. One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days per 500m of pavement

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications:

- bedding sand
- steel mesh/reinforcement

- dowels
- formwork
- aggregate
- water
- concrete placing and finish

A Slump Test will be carried out on every concrete batching shift, or as directed by the Supervising Engineer. The slump shall be 40 - 60mm (with membrane) or 60-80mm (without membrane). Concrete exceeding these criteria will be rejected.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the SRC pavement by the Supervising Engineer's Representative prior to acceptance of the Works.

DRAFT SPECIFICATION RRST 403

NON-REINFORCED CONCRETE PAVEMENT (NRC)

403.1 DESCRIPTION

The work comprises providing materials for and constructing non-reinforced Portland cement concrete slabs, together with associated load transferring dowels and joint sealing materials, laid to lines, levels and dimensions, as shown on the Engineering Drawings and as directed by the Supervising Engineer.

403.2 MATERIALS

The following paragraphs define target specifications for natural materials and products that should be used in the construction of this pavement layer. In the event that appropriate material or products cannot be reasonably obtained then the Contractor may submit alternative materials and products to the Supervising Engineer for approval. This approval may involve adjustments to the pavement design. Under no circumstances may the Contractor use non-specification materials without the prior approval of the Supervising Engineer.

Concrete

Concrete shall be Grade 200 and have a minimum compressive strength of 20Mpa (28 days) with a guidance mix water/cement ratio of 0.45. Concrete mix proportions should be calculated to suit the available materials in order to meet the required compressive strength and slump requirements The use of low water-cement ratios (e.g. <0.45), higher cement contents, plasticiser and high early-strength cement is beneficial in minimising the risk of cracks. Concrete shall otherwise be constructed to the requirements of current Vietnamese Standards.

Concrete Aggregate

(Concrete aggregates shall conform to the current Vietnam Standards applicable to crushed stone aggregate for rural roads (TCVN 1771: 1987; TCVN 1772:1987). No uncrushed rounded coarse natural aggregate shall be permitted.

Load Transfer Dowels

Load transfer dowels shall be provided at each joint between slabs. They shall be made with 14 mm diameter mild steel reinforcing bars, 500mm in length. The steel shall comply with current Vietnamese Standards related to concrete reinforcement.

403.3 CONSTRUCTION METHODS

NRC pavement shall be constructed on a previously prepared sand bedding layer (Specification RRST 209) that has been examined and accepted by the Supervising Engineer's Representative. An impervious plastic membrane may be placed on top of the prepared sand bedding layer prior to concrete placement to inhibit moisture loss from the concrete. If a membrane is not employed then the sand bedding layer must in soaked, compacted and undisturbed state immediately prior to concrete pavement placement.

Joints

Partial depth Contraction joints of 10mm width are to be provided at 5m intervals in the pavement, to relieve tensile stresses. Full depth Expansion joints of 10mm width are to be provided at 250m intervals. All joints are to be filled and sealed with a mixture of sand and bitumen, with a reservoir of bitumen provided at the top of each joint. All joints are to be provided with load transfer steel dowels.

14mm diameter mild steel reinforcing bars of 500mm length are to be placed at 250mm centres at all expansion and contraction joints.

At expansion joints the dowel bar should be anchored into the concrete at one end and the other end coated with bitumen and fitted into a PVC sleeve. The PVC tube is to be omitted at contraction joints.

Concrete slabs should normally be constructed at full carriageway width. In some circumstances (e.g. to allow traffic flow in difficult terrain) construction of half-width concrete slabs may be permitted, but only with the agreement of the Supervising Engineer. Longitudinal joints should have a load transferring dowel and sealing arrangement similar to that of transverse contraction joints. In low volume roads (Commune Class B) it may be permissible to use profiled formwork to produce a "tongue in groove" load transferring arrangement for longitudinal joints in place of dowels.

Concrete

All concrete shall be mixed on site in small capacity batch mixers complying with the appropriate Vietnamese Standards. Mixers with a capacity less than one bag of cement shall not be used and no mixer shall be charged in excess of its rated capacity. Cement shall be fresh and stored in a clean dry location. Aggregates shall be stored separately in a clean area. Proportions of aggregates shall be measured using weighing apparatus or batching boxes. Water should be fresh not brackish (total salt content <5,000mg/litre) and not contaminated by industrial or other waste. Water proportions shall be determined using containers of known volume.

All formwork shall be well secured and free from defects or gaps, and able to resist the tamping forces. The top edge of the formwork shall be within ± 2mm of the required finished road levels. Prior to placing the concrete, all formwork shall be thoroughly inspected and passed by the Supervising Engineer's Representative. All wood chips, dust, sand, construction debris and any other deleterious material shall be removed from the formwork and sand bedding layer prior to placing the concrete. All formwork shall be wetted to ensure it is damp when the concrete is poured. Care should be taken during this operation such that pools of excess water do not form in the base of the formwork.

Once the concrete had been placed uniformly within the forms, compaction shall be carried out using a mechanical poker vibrator. Care should be taken to ensure a good bond between layers of fresh concrete placed separately by vibrating the two layers together until a satisfactorily homogenous cross section is obtained.

No concrete shall be compacted after initial setting has commenced. All concrete shall be compacted until no air bubbles appear on the surface of the fresh concrete. Care shall be taken not to touch the formwork with the vibrator since this would result in concrete having begun initial setting being exposed to re-vibration.

After placement and compaction, the camber shall be shaped in the fresh concrete to lines and levels detailed in the Engineering Drawings. In order to improve the skid-resistance of the surface and to minimise the vehicles' breaking distance, transverse grooves shall be etched in the fresh concrete surface utilising an appropriate rake.

The concrete shall be cured by spreading sand or sacking over the surface of the pavement and repeatedly wetting the materials for a period of at least 7 days. The Supervising Engineer may direct a longer curing period depending on local circumstances. No traffic shall be allowed on the pavement until a period of 14 days has elapsed. Suitable temporary diversions should be made for continued flow of normal traffic.

Concrete shall not be mixed or poured when ambient shade temperatures are less than 4 degrees Celsius or more than 38 degrees Celsius.

55.4 CONSTRUCTION EQUIPMENT

The following equipment, apparatus and special handtools shall be used:

- Formwork
- Concrete mixer of at least 250 litre capacity
- Batching boxes or weighing apparatus
- Wheelbarrows
- Vibrating poker powered by electricity or portable generator
- Tamping screed
- Portable sun protection canopy if casting in direct sunlight if ambient shade temperatures are above 25 degrees Celsius
- Grooving rake

403.5 MEASUREMENT

The unit of measurement shall be square metres (m^2) of constructed non-reinforced concrete. The quantity for which payment shall be made shall be the product of the instructed average width and the measured length along the centre line of the road.

The rates shall include the supply, placing, spreading, shaping, watering and compaction as specified and shown on the Drawings.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the materials, and providing all labour, tools, equipment, formwork, incidentals necessary, overheads and profit.

Pay Item shall be:

CLAUSE	DESCRIPTION	UNIT OF MEASUREMENT
403	200mm Non-Reinforced Concrete	Square metre

403.6 LABORATORY & SITE TESTING

General

The Supervising Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated here in under. The frequencies are the minimum. The Supervising Engineer shall have the authority to have these tests conducted at more frequent intervals where quality of a material or work is in doubt.

Laboratory Testing

TYPE OF TEST	FREQUENCY OF TEST
Aggregate properties as defined in relevant Vietnamese Standards	One set per 1km (more frequently if material character changes)
Concrete cube strength	One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days for mix design per materials source. One set of 3 cubes to be crushed at 7 days and one set of 3 cubes to be crushed at 28 days per 500m of pavement

Site Testing

Visual inspections will be made to check compliance with the drawings and specifications:

- bedding sand
- dowels
- formwork
- aggregate
- water
- concrete placing and finish

A Slump Test will be carried out on every concrete batching shift, or as directed by the Supervising Engineer. The slump shall be 40 - 60mm (with membrane) or 60-80mm (without membrane). Concrete exceeding these criteria will be rejected.

A pavement layer quality and specification compliance inspection will be undertaken on all completed sections of the NRC pavement by the Supervising Engineer's Representative prior to acceptance of the Works.

SEACAP 1

FINAL REPORT

APPENDIX M

Trials Cost Norms

Draft cost norms for each trial options under RRST-II, already approved by the steering committee for use in RRST-I

06/09/2005

Ref.	Norm	Measurement unit	Total Amount									Notes
			Material	Unit	Amount	**Labour**	Unit	Amount	**Equipment**	Unit	Amount	
35a	Natural gravel Shoulder	m3	a. Gravel- 15cm Natural gravel	 m3	 1428	Level 2,5/7	man-day	0.25	8.5T Steel roller 5m3 Tank truck 20 CV Pump	Shift Shift Shift	0.0111 0.0111 0.00556	To apply CD 79
35b	Lime stabilised local soils shoulder	m3	b.Lime stabilised local soil 5% - 15cm Local clayer soil Powder lime Fine sand Other materials	m3 m3 kg m3 %	 1.498 96 0.335 1	Level 4,0/7	manday	0.54	8.5T Steel roller Single axle rotovator 60cv 5m3 Tank truck	Shift Shift Shift	0.0095 0.03 0.0025	To adapt EB.4132
35c	Cement stabilised local soil shoulder	m3	c.Cement stabilised local soil 5%-15cm Local sandy soil Cement Other materials	m3 m3 kg %	 1.22 90 1	Level 4,0/7	manday	0.44	8.5T Steel roller Single axle rotovator 60cv 5m3 Water spray truck	Shift Shift Shift	0.0095 0.025 0.0025	To adapt EB.4132
36	Natural gravel sub-base	m3	Natural gravel	m3	1.428	Level 2,5/7	manday	0.0316	8,5T Steel roller 5m3 tank truck 20CV Pump 108CV grader	Shift Shift Shift Shift	0.0111 0.0111 0.00556 0.00556	To apply CD 79
37a	Lime stabilised soil-Base	m3	Local clayer soil - 15cm Powde lime - 7% Fine sand Other materials	m3 kg m3 %	1.498 128 0.335 1	Level 4,0/7	manday	0.36	8.5T Steel roller Single axle rotovator 60cv 108CV Grader 5m3 Tank truck	Shift Shift Shift Shift	0.0095 0.03 0.0075 0.0025	To adapt EB.4132
37b	Lime stabilised soil-sub-base	m3	Local clayer soil - 15cm Powde lime - 5% Fine sand Other materials	m3 kg m3 %	1.498 96 0.335 1	Level 4,0/7	manday	0.36	8.5T Steel roller Single axle rotovator 60cv 108CV Grader 5m3 Tank truck	Shift Shift Shift Shift	0.0095 0.03 0.0075 0.0025	To adapt EB.4132
38a	Cement stabilised soil - base	m3	Local sandy soil - 15cm Cement - 5% Other materials Fine sand	m3 kg % m3	1.22 102 1 0.335	Level 4,0/7	manday	0.29	8.5T Steel roller Single axle rotovator 60cv 108CV Grader 5m3 Tank truck	Shift Shift Shift Shift	0.0095 0.025 0.0075 0.0025	according to EB.4132
38b	Cement stabilised soil - subbase	m3	Local sandy soil - 15cm Cement - 3% Other materials Fine sand	m3 kg % m3	1.22 68 1 0.335	Level 4,0/7	manday	0.29	8.5T Steel roller Single axle rotovator 60cv 108CV Grader 5m3 Tank truck	Shift Shift Shift Shift	0.0095 0.025 0.0075 0.0025	To adapt EB.4132
39a	Emulsion Stabilised Soil Roadbase	m3	Local Soil -15cm Bitumen Emulsion - 3%	m3 lit	1.22 90.3	Level 4,0/7	manday	0.41	108CV Rotovator 8,5T steel roller 5m3 water spray truck	Shift Shift Shift	0.04 0.00985 0.0025	To adapt EB.4132
39b	Emulsion Stabilised Soil Sub-Base	m3	Local Soil - 15cm Bitumen Emulsion - 2%	m3 lit	1.22 61.3	Level 4.0/7	manday	0.41	108CV Rotovator 8,5T steel roller 5m3 water spray truck	Shift Shift Shift	0.04 0.00985 0.0025	To adapt EB.4132
40	Dry bound macadam Road base	m3	Chippings 4x6cm Fine stones <5mm	m3 m3	1.319 0.466	Level 2,7/7	manday	1.2	8.5T Steel roller Other equipment	Shift %	0.1838 5	

Ref.	Norm	Measurement unit	Total Amount									Notes
			Material	Unit	Amount	**Labour**	Unit	Amount	**Equipment**	Unit	Amount	
41	Amoured gravel-10cm	m3	Crushed stone - 10cm 0,075 - 37,5mm	m3	1.38	Level 4,0/7	manday	0.039	8T Vibrating roller 5m3 tank truck 108CV Grader 10T Steel roller Other equipment	Shift Shift %	0.0085 0.0021 0.0008 0.0021 0.5	To adapt EB.4132
42	Sand beding	m3	Beding sand Other materials	m3 %	1.22 2	Level 2,7/7	manday	0.56	60kg Vibrating Plate Compactor	Shift	0.033	To adapt EB.4132
43	Mortared Dressed Stone Surfacing	m2	Stone Setts (10x20x30cm) Cement Mortar - 7,5Mpa Cement PC30 Fine sand	P m3 kg m3	29.3 0.029 10.441 0.030	Level 3,5/7	manday	0.438 (2,19md/m3) GA.4110	80kg Vibrating Plate Compactor	Shift	0.05	To apply GA4110 Cement mortar use Norm number B.1234
44.1	Stone chip Emulsion Seal	m2	Bitumen emulsion- CRS Preme coat emulsion- CRS Chipping 14mm	kg kg m3	2.996 0.642 0.0166	Level 4,0/7	manday	0.0442	8.5T Steel roller	Shift	0.0021	To adapt XR.3341/29
44.2	Stone chip Emulsion Seal	m2	Bitumen emulsion- CRS Preme coat emulsion- CRS Chipping10mm	kg kg m3	2.461 0.642 0.0166	Level 4,0/7	manday	0.0442	8.5T Steel roller	Shift	0.0021	To adapt XR.3341/29
44.3	Stone chip Emulsion Seal	m2	Bitumen emulsion- CRS Preme coat emulsion- CRS Chipping 6mm	kg kg m3	1.926 0.642 0.0166	Level 4,0/7	manday	0.0442	8.5T Steel roller	Shift	0.0021	To adapt XR.3341/29
45	Sand Emulsion seal	m2	Bitumen emulsion- CRS Preme coat emulsion- CRS Coarse sand	kg kg m3	1.926 0.642 0.0166	Level 4,0/7	manday	0.0442	8.5T Steel roller	Shift	0.0021	To adapt XR.3341/29
46	Bitumen penetration macadam	m2	Chipping 4x6 Chipping 2x4 Chipping 0,5x1 Fire wood Bitumen	m3 m3 m3 kg kg	0.0792 0.02 0.022 6.4 7.49	Level 3,5/7	manday	0.146	8.5T Steel roller	Shift	0.013	To adapt EC.4022 and EC.4312
48	Fire Clay Brick (Un-Motarred) Pavement	m2	Clay Brick 20x10x5cm Coarse sand	Piece m3	81 0.0260	Level 3,5/7	manday	0.12	80kg Vibrating Plate Compactor	Shift	0.005	To apply SA.2110
49	Fire Clay Brick (Motared) Pavement	m2	Clay Brick 20x10x5cm Cement Motared - Cement PC30 - Fine sand	Piece m3 kg m3	81 0.045 16.2 0.0595	Level 3,5/7	manday	0.3				To apply SA.2110 To apply B.1234 for cement motared
50	Cement Concrete Brick (Un-Motarred) Pavement	m2	Concrete Brick 20x10x7cm Coarse sand	Piece m3	44.5 0.0118	BËc 3,5/7	manday	0.156	80kg Vibrating Plate Compactor	Shift	0.005	To apply SA.2110

Ref.	Norm	Measurement unit	Total Amount								Notes
			Material	Unit	Amount	**Labour**	Unit	Amount	**Equipment**	Unit	Amount	
51a	**Concrete mix**	m3	Cement PC30	kg	342x1.025	BËc 4,0/7	manday	1.82	Mixture machine	Shift	0.095	
52a &55a	class 200, slump		Coarse sand	m3	0.469x1.025				Plate compactor	Shift	0.089	
	2 - 4cm		Chipping 1x2cm	m3	0.878x1.025				Vibrating pocker	Shift	0.089	
			Water	m3	0.185x1.025							HA.8110
			Bitumen	kg	3.5							
			Joint wood	m3	0.014							
			Other material	%	1.5							
51b	Bamboo reinforced	m2	Bamboo splint 1x2,5cm	m	12.72	Level 3,5/7	manday	0.2495				
			Iron Wire	kg	0.0428							
			Load transfer steel d14	kg	1.02	Level 3,5/7	manday	0.00834	23KW Soldering machine	Shift	0.0012	To adapt IA.1120
51c, 52c &55b	Load transfer steel	kg	Iron Wire	kg	0.01428				Steel cutter	Shift	0.00032	
			Soldering stick	kg	0.00464							
51d	Plate and remove	m2	Formwork	m3	0.0134	Level 3,5/7	manday	0.1361				To adapt KA.1110
52d &55c	formwork		Nail	kg	0.12							
			Other material	%	1							
52b	Steel reinforced	kg	Steel mesh d= d6	kg	1.005	Level 3,5/7	manday	0.1132	23KW Soldering machine	Shift	0.0004	To adapt IA.1110
			Iron Wire	kg	0.02412							

Note: The cost Norms for options 35 to 52 has been approved by the RRST Steering Committee for RRST-I. The new cost norms of 56 and 58 have been additionally developed by Intech-TRL for RRST-II.

Draft cost norms for each trial options under RRST-II

06-09-05

Ref.	Norm	Measurement unit	Total Amount									Notes
			Material	Unit	Amount	**Labour**	Unit	Amount	**Equipment**	Unit	Amount	
56	Quarry run Road base	m3	Quarry-run	m3	1.4	Level 2,7/7	manday	0.0316	8,5T Steel roller	Shift	0.12	
									Tank truck 5m3	Shift	0.0111	To adapt the norm
									Pump 20CV	Shift	0.00556	for hill gravel
									Grader 108CV	Shift	0.00556	
58	Cobble stone Pavement	m3	Cobble stone 10x10x15cm	m3	1.2	Level 3,5/7	manday	0.438	60kg Vibrating Plate	Shift	0.065	Labour - GA.5110
			Fine stone	m3	0.33				Compactor			

Note: The cost Norms for options 35 to 52 has been approved by the RRST Steering Committee for RRST-I. The new Norms of 56 and 58 have been additionally developed by Intech-TRL for RRST-II.