

# **Rural Road Surfacing Research SEACAP 1 Trials Dissemination Workshop**

## **Technical Recommendations**

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# Technical Recommendations

Differing approaches in the two RRST trial programmes in conjunction with the associated gravel studies (SEACAP 4) have allowed a wide range of technical recommendations to emerge from the RRSR; not only with respect to the options themselves but also on key issues such as contractor capability, technical supervision and quality assurance.

# Key Technical Recommendations

**Assessments of a range of rural road options**

**Appropriate use of construction materials**

**Technical specifications**

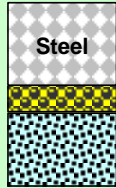
**Selection framework for pavement options**

**Construction and quality control**

**Appropriate low volume rural road standards**

# Pavement Options Defined

**OPTION B**  
Steel reinforced 20MPa concrete



Typical Thicknesses  
mm

120	150	200
50	50	50
100	120	150

Bedded on compacted sand

Lime/cement stabilised soil, CBR >30%

**OPTION C**  
Bamboo reinforced 20MPa concrete



Typical Thicknesses  
mm

120	150	200
50	50	50
100	150	200

Bedded on compacted sand

Natural gravel base CBR>30%

**OPTION D**  
Bamboo reinforced 20MPa concrete



Typical Thicknesses  
mm

120	150	200
50	50	50
100	120	150

Bedded on compacted sand

Compacted sand base, CBR > 30%

**OPTION E**  
Steel reinforced concrete  
15cm



Typical Thicknesses  
mm

120	150	200
50	50	50
100	120	150

Compacted sand base, CBR > 30%

**OPTION F**  
Emulsion sand & stone chip seals  
Dry bound macadam



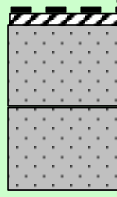
Typical Thicknesses  
mm

100	120	150
100	120	150
100	120	150

Dry bound macadam

Compacted sand sub-base, CBR >30%

**OPTION M**  
Emulsion sand & stone chip seals



Typical Thicknesses  
mm

100	120	150
100	120	150

Emulsion stabilised soil; CBR 45%

Emulsion stabilised soil; 30%

**OPTION N**  
Emulsion sand seal  
Concrete bricks  
Compacted sand



Typical Thicknesses  
mm

70	80	100
50	50	50
100	120	150
100	120	150

Natural gravel; CBR >30%

Natural gravel, CBR >30%

**OPTION O**  
Emulsion sand seal  
Concrete bricks  
Compacted sand



Typical Thicknesses  
mm

70	80	100
50	50	50
100	120	150
100	120	150

Dry bound macadam

Dry bound macadam

**OPTION P**  
Emulsion sand seal  
Crushed stone armouring; CBR 50%



Typical Thicknesses  
mm

50	70	100
100	120	150
100	120	150

Natural gravel, CBR >30%

Natural gravel, CBR >30%

# Bamboo Reinforced Concrete

## ADVANTAGES

- Very Heavy duty for traffic
- Suited to labour-based small contractor/community approach.
- Erosion resistant, durable, very low maintenance and easily repairable.
- Not constrained by gradient.
- High residual value on materials.
- Ideal for low strength sub-grades



## DISADVANTAGES

- High initial costs.
- Sensitive to cement costs

# Bituminous Chip Seal



## ADVANTAGES

- Widely used intermediate technology option.
- Good performance record if well constructed (seal life up to 14 years).
- Can be used as a low cost maintenance treatment on some surfaces.

## DISADVANTAGES

- Requires good construction control on road base preparation and on binder & aggregate spreading.
- Requires suitable supply of quality aggregate.



Intech  
Associates



# Pavement Option Advantages-Disadvantages

- 1** Positive advantage  
**2** Probable advantage  
**0** No advantage/disadvantage  
**X** Definite disadvantage

Trial and Control Pavement layers	Key Markers												
	Local material Use*	Labour-Based	Ease of Construction	Maintenance reduction	Sustainability	Resistance to Rainfall/Flooding	Small Contractor Suitability	Local Economy Advantages	Resistance to Axle Overloading	Likely Female Employment	User advantages (Low Roughness)**		
Emulsion Sand/Stone Chip Seals	0	1	0	2	2	2	0	1	0	0	2	0	2
Lime stabilised Base/Sub-base	1	0	2	0	1	0	X	1	0	0	X	2	0
Cement Stabilised Base/Sub-base	1	0	2	0	1	0	X	1	0	0	X	2	0
Emulsion Stabilised Sub-Base	1	X	0	0	0	0	X	X	0	0	0	0	0
Sealed Dry-Bound Macadam	0	0	2	2	1	2	0	2	0	2	0	2	2
Dressed Stone	1	1	2	1	1	1	1	1	1	1	2	2	X
Fired Clay Bricks	1	1	2	1	2	2	1	1	1	2	1	2	0
Concrete Bricks	2	1	2	1	2	2	1	1	2	2	1	2	0
Sealed Armoured Gravel	2	0	2	2	2	2	0	2	0	X	0	2	2
Steel Reinforced Concrete	0	2	0	1	1	1	1	2	0	1	0	0	1
Bamboo Reinforced Concrete	2	2	2	1	1	1	1	1	2	1	1	2	1
Unsealed Natural Gravel	1	0	1	X	X	X	0	1	2	0	0	X	X
Penetration Macadam	X	X	0	2	2	2	0	0	0	0	0	0	2
Unsealed Water-Bound Macadam	0	0	2	X	X	X	0	2	0	0	2	0	X

# Local Materials

A key objective in sustainable rural road design is to best match the available material to the road task and the local environment.

The use of locally available, but possibly non-standard, pavement construction materials plays a significant role within this concept



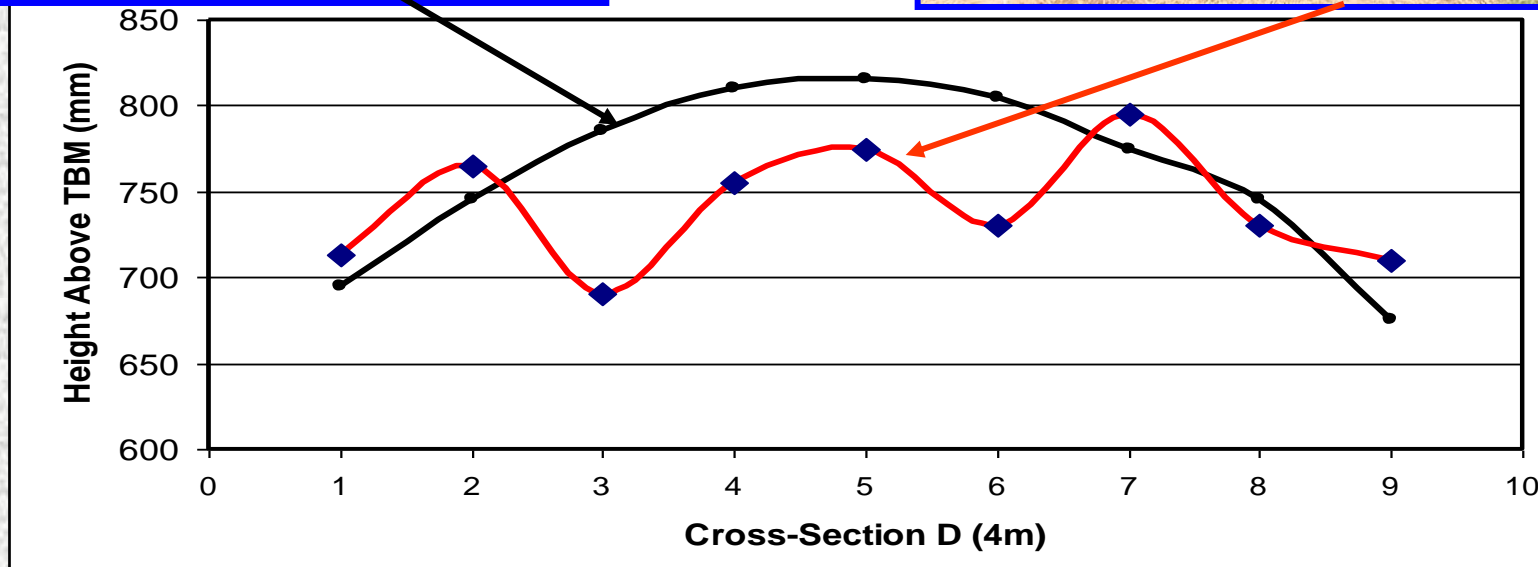
# Appropriate Use of Gravel

**Significant technical constraints have been recommended on the use unsealed gravel pavements in terms of :**

**Long hauls, high rainfall, high traffic, poor material, steep gradients, flooding, poor construction practices and lack of maintenance capacity.**

**These recommendations have been incorporated into a gravel use flow chart**

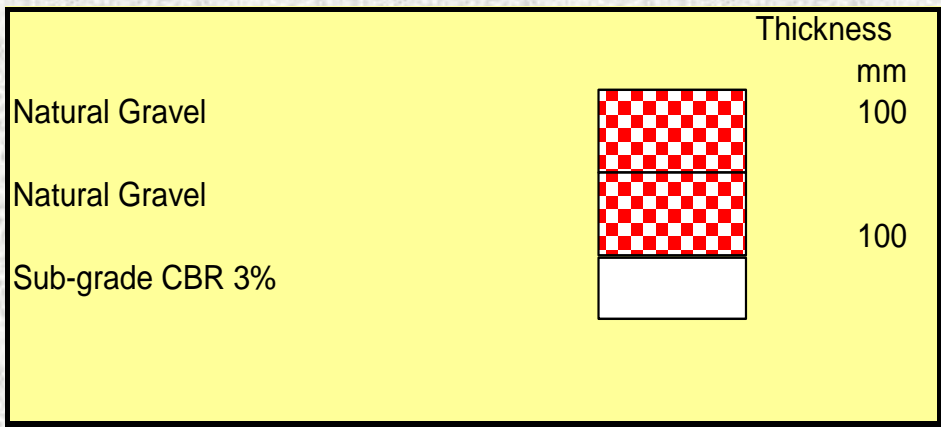
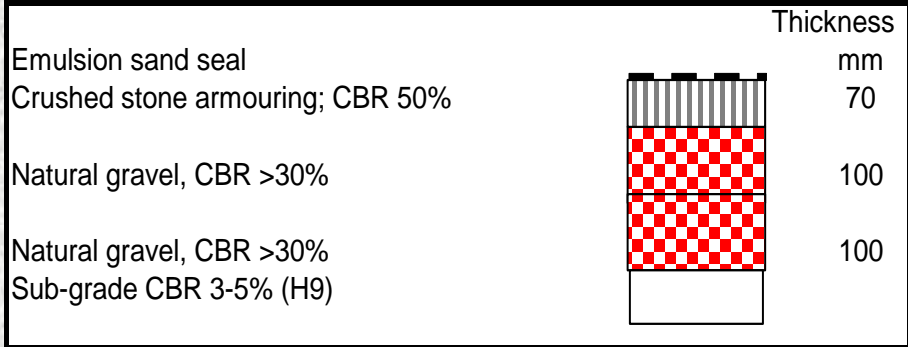
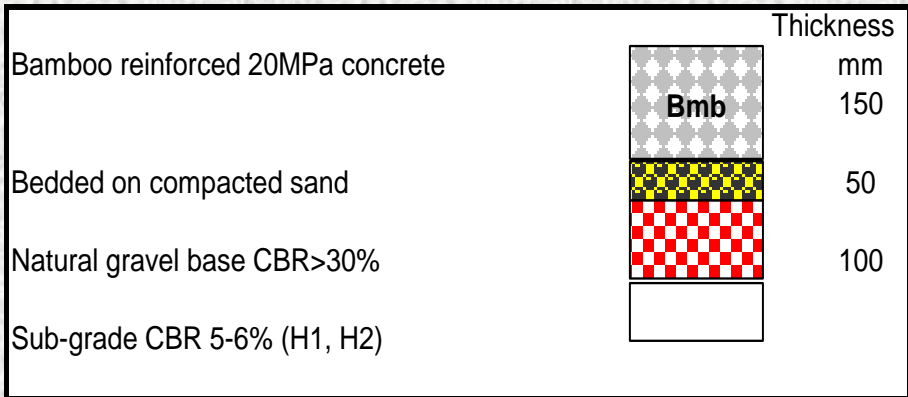
# Hue Gravel Control Section



# Appropriate Use of Gravel

The research has clearly indicated that there are appropriate uses for suitable quality laterite, colluvial and alluvial gravels:

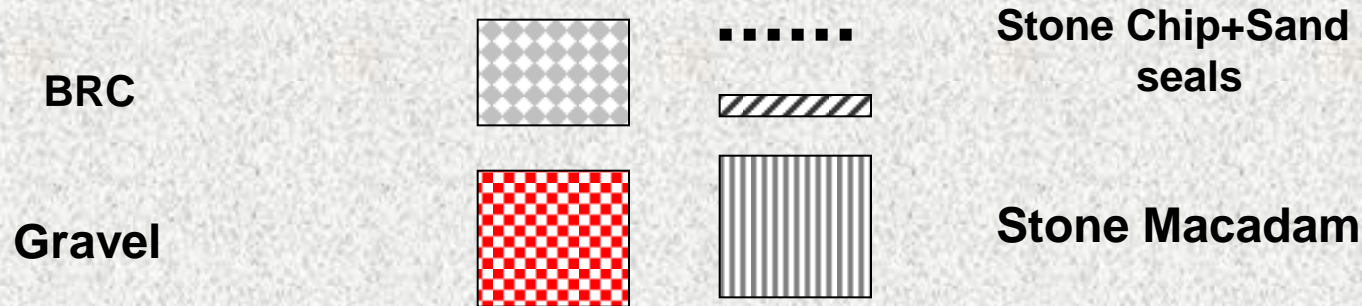
- ❑ As an unsealed road surface or shoulder material in certain road environments
- ❑ As a base or sub-base material
- ❑ As a temporary road surface within a staged construction programme



**Gravel has been trialled in the RRST programmes as a sub-base or base as well as being used as unsealed control sections**

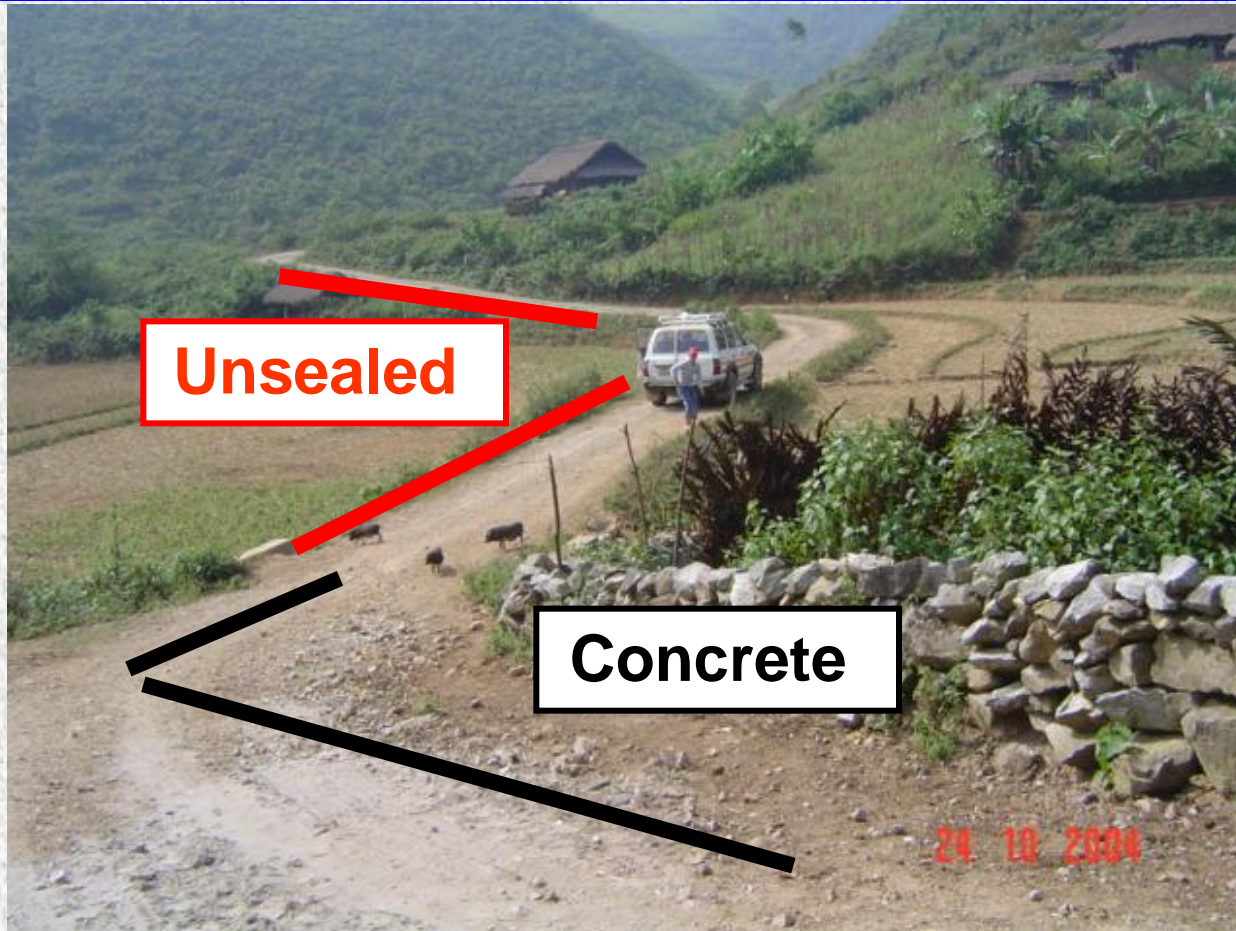


# Staged Construction



When the funds available immediately are limited, but more funding is reliably expected in the future, a 'Stage Construction' approach may be used. This involves providing a basic improvement of the surface initially, then providing further pavement layers later as resources permit.

# Composite Construction (Spot Improvement)



# Flexibility in Pavement Design

**Modify the material to  
suit the pavement  
options**



**Modify the options to  
suit the materials  
available,**



# Appropriate Specifications

By necessity, general specifications must cover a very wide range of material types and environments. As a consequence they are likely to contain significant in-built factors-of-safety.

However, proven specifications drawn-up for specific materials for particular environments need not be so conservative in approach.

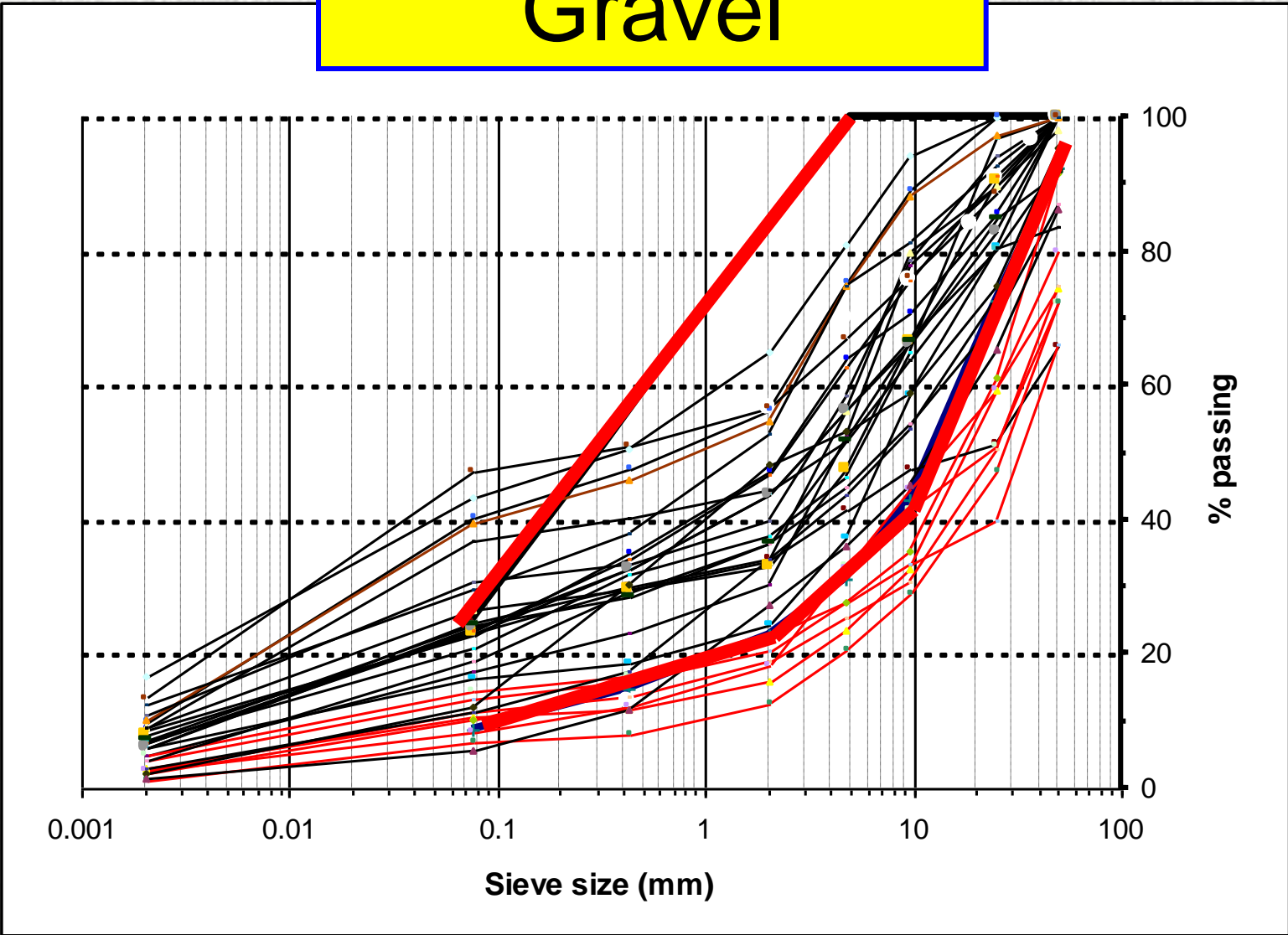
# Appropriate Specifications

Appropriate to the road function

Appropriate to available materials

Specifications must to be realistic and achievable – otherwise they are pointless

# Gravel



# New Specifications

Seals

Reference	Specification
RRST 1-01	Bituminous Emulsion – Surface Dressing Chip seal
RRST 1-02	Bituminous Emulsion – Sand Seal
RRST 2-01	Gravel Sub-Base/Base
RRST 2-02	Lime Stabilised Sub-Base/Base
RRST 2-03	Cement Stabilised Sub-Base/Base
RRST 2-04	Emulsion Stabilised Sub-Base/Base
RRST 2-05	Armoured Gravel Roadbase
RRST 2-06	Sand Sub-Base
RRST 2-07	Quarry-Run Sub-Base
RRST 2-08	Graded Crushed Stone Sub-Base/Base
RRST 2-09	Sand Bedding Layer
RRST 2-10	Dry Bound Macadam Sub-Base/Base

Sub-Base -  
Base

# New Specifications

Block  
Paving

**RRST 3-01 Fired Clay Brick Pavement – Unmortared Joints**

**RRST 3-02 Fired Clay Brick Pavement – Mortared Joints**

**RRST 3-03 Cement Brick Pavement – Mortared Joints**

**RRST 3-04 Mortared Dressed Stone**

**RRST 3-05 Cobble Stone Paved Surface**

Concrete

**RRST 4-01 Bamboo Reinforced Concrete**

**RRST 4-02 Steel Reinforced Concrete**

**RRST 4-03 Non-Reinforced Concrete**

Shoulders

**RRST 5-01 Gravel Shoulders**

**RRST 5-02 Lime Stabilised Shoulders**

**RRST 5-03 Cement Stabilised Shoulders**

**RRST 5-04 Quarry-Run Shoulders**

**RRST 5-05 Sealed Macadam Shoulders**

# Specification Guides

Each specification will be accompanied by a short technical guide illustrating and highlighting key aspects in the construction or supervising procedures



# Rural road Pavement Selection

The initial selection of pavement type should be on a whole range of factors that cumulatively can be described as the “road environment”, namely:

- Construction materials
- Climate/rainfall
- Hydrology
- Terrain
- Traffic/axle load
- Construction regime
- Maintenance regime

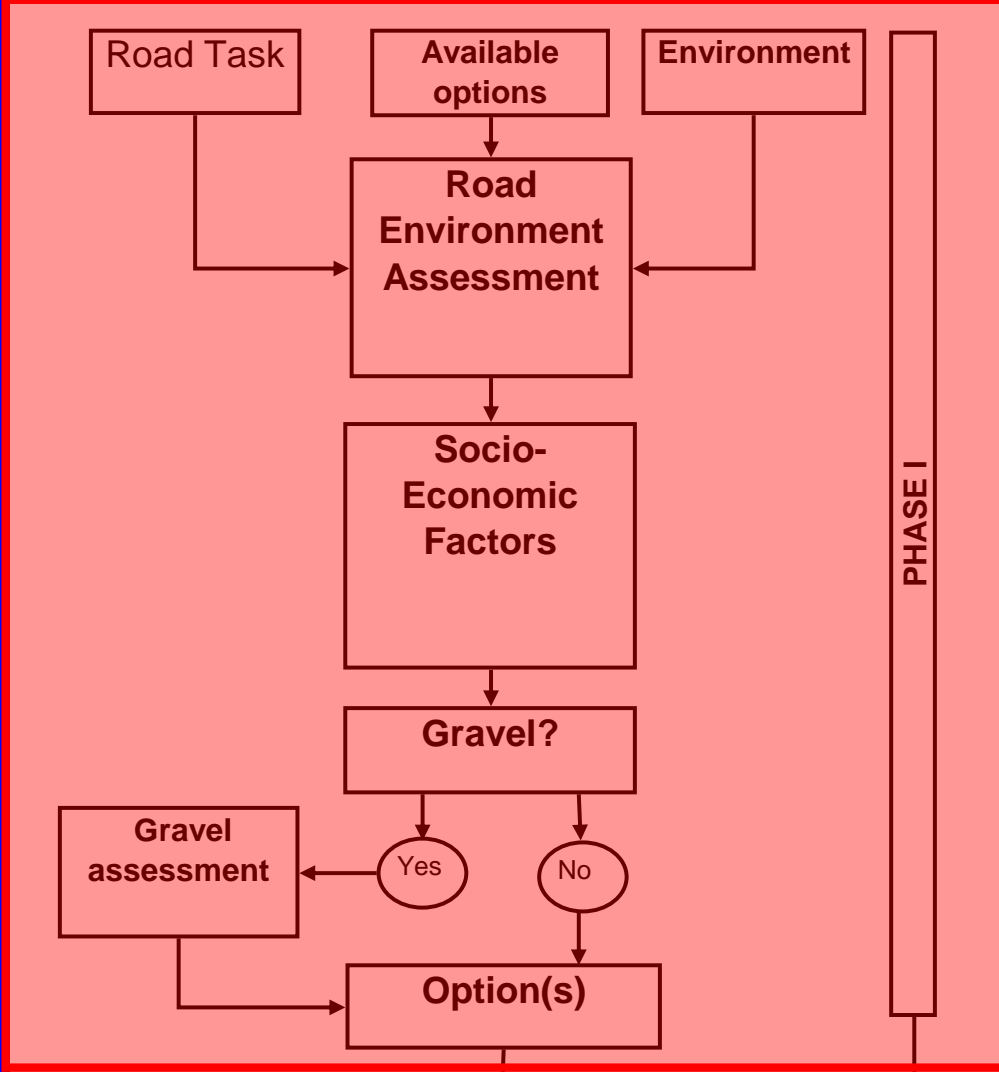


# Rural road Pavement Selection

The procedures for the selection of low volume rural road paving are based on two key principles:

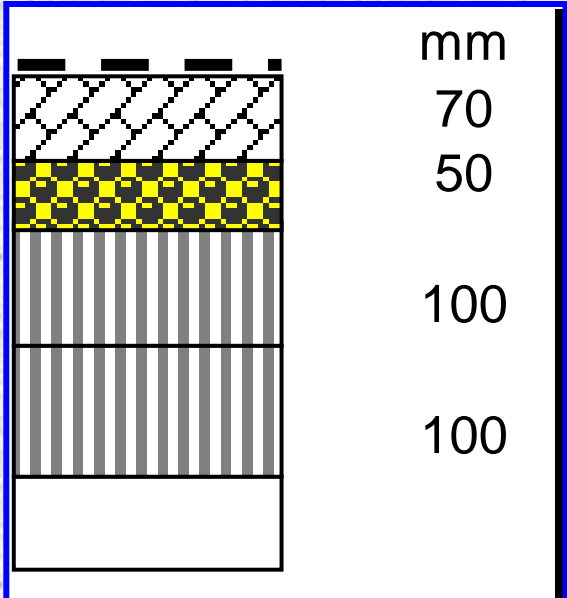
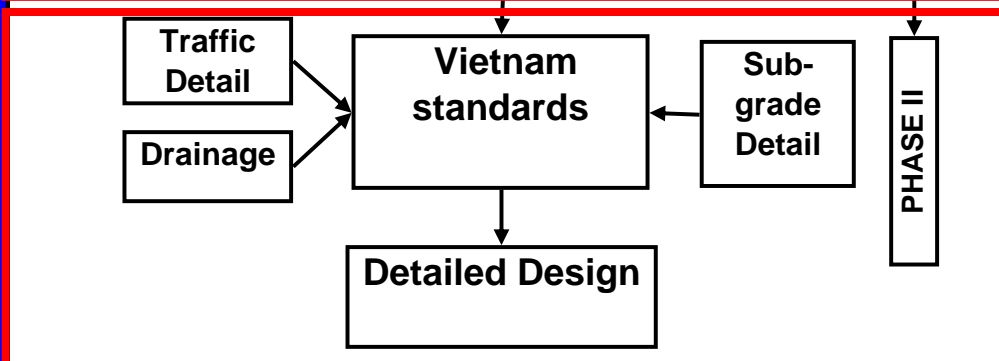
1. The pavements should be compatible with the governing road environment factors.
2. The pavements must be fit for purpose in terms of traffic volume and axle loads,

The above two principles are an extension of the approach to pavement design which is based predominantly on traffic/axle load and sub-grade strength. Experience indicates that additional road environment factors must be taken into account if the selected designs are to be cost-effective and sustainable in engineering, social and economic terms



**Phase I**  
 Selection of appropriate general pavement type or types

**Phase II**  
 Detailed design of selected option

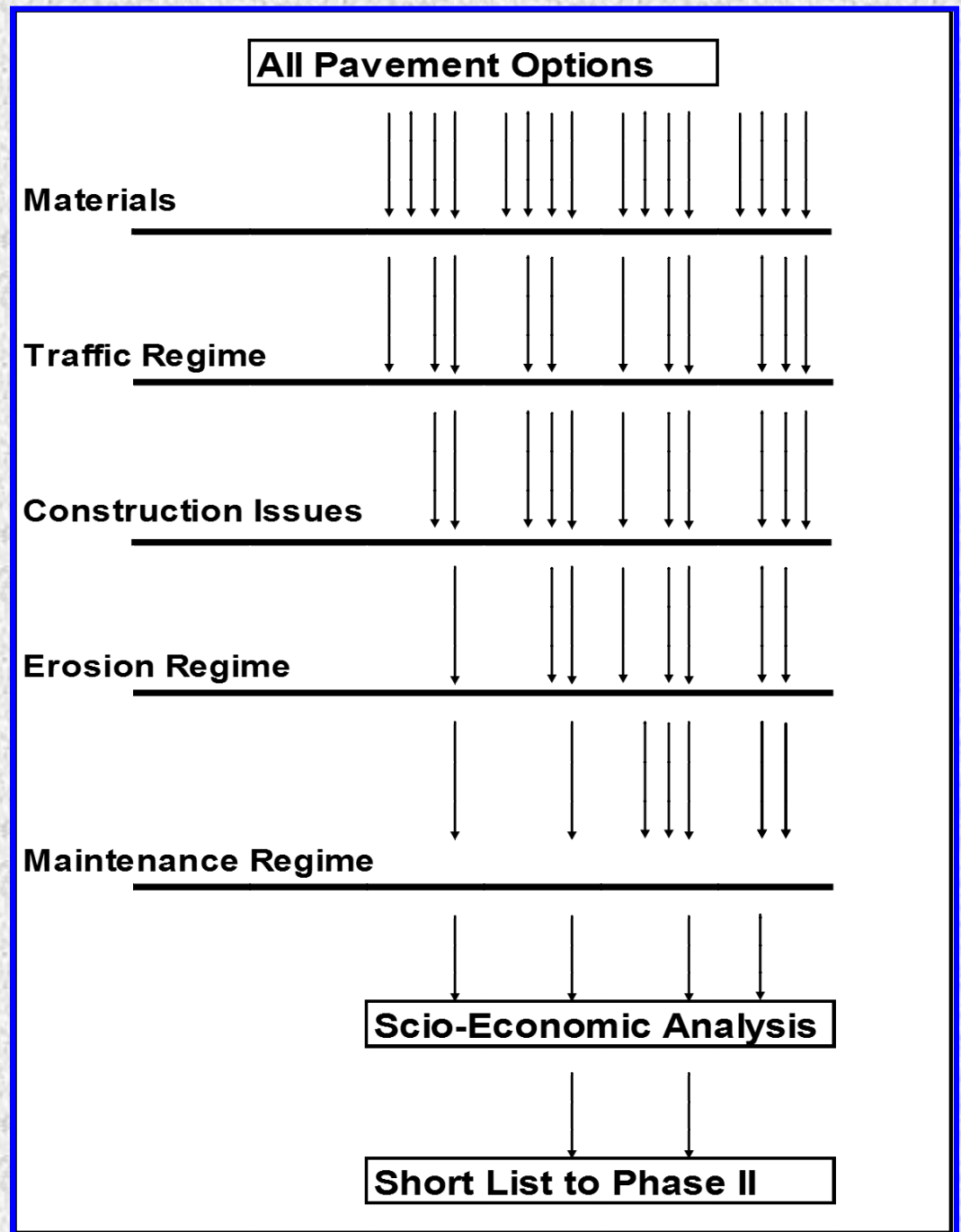


# Primary Engineering Filter

	Seals and Load Bearing Surfaces									Bases							
	Sand seal	Chip seal	Penetration macadam	Steel reinforced concrete	Bamboo reinforced concrete	Engineering clay bricks	Concrete bricks	Stone setts	Unsealed wet/dry macadam	Unsealed gravel	Waterbound macadam	Drybound macadam	Natural gravel	Armoured gravel	Cement stabilised soil	Lime stabilised soil	Emulsion stabilised soil
<b>Economically available Materials</b>																	
Crushed stone aggregate		√	√	√	√		√		√		√	√		√			
Stone blocks								√									
Laterite gravel										√			√	√			
Colluvial/alluvial gravel										√			√	√			
Weathered rock														√			
Fired clay bricks						√											
Clay soil						√										√	
Sand	√			√	√		√								√		√
Cement				√	√		√								√		
Lime																√	
Bitumen			√														
Bitumen Emulsion	√	√															√

## Phase I Option Identification

Option suitability will depend on local circumstances and a formal system of assessment will enable unsuitable options to be filtered out before a short list goes forward to the design stage.



# THE ROAD ENVIRONMENT

**DRAINAGE AND  
HYDROLOGY**

**PREVAILING  
CLIMATE**

**AVAILABLE  
MATERIALS**

**TERRAIN  
GEOLOGY**

**OPTIMUM OR  
APPROPRIATE  
PAVEMENT  
DESIGN**

**CONSTRUCTION  
REGIME**

**SUB-GRADE  
CONDITIONS**

**MAINTENANCE  
REGIME**

**THE “GREEN”  
ENVIRONMENT**

**TRAFFIC  
AXLE LOADS**

# Construction Regime

**Contractor training:**                      **Construction methods**  
**Construction plant**

**Local consultant strengthening**  
**Appropriate design**  
**Supervision**

**Quality Assurance**                      **Materials control**  
**Layer dimensions, strength**  
**Drainage**

# Quality Assurance

Roads should be constructed with appropriate supervision and quality control

1. Materials approvals
2. Pavement layer approvals
3. In situ testing
4. As-completed Quality Assessment



# Maintenance Regime

Unrealistic assumptions are almost always made as to likely maintenance inputs. when planning road programs.

**The gravel survey in 2004 indicated that over 70% of roads were receiving no maintenance of any kind and less than 10% were receiving any form of periodic maintenance.**

Although the immediate focus may be on the absolute unsuitability of gravel as an option if no maintenance regime is in place. **There is a longer term problem awaiting other surfaces – eg bitumen or emulsion seals**

# Maintenance Materials

Local or commune driven maintenance will tend to use immediately available local materials – from within the commune.

If original gravel is hauled 25-50-100Km  
.....?



**Maintenance causing  
gravel surface  
deterioration to earth  
condition**

# Summary

Significant progress has been made in researching and recommending appropriate rural road options and already this has made significant and relevant impacts in the sector



**BUT**

The crucial follow-up phase is NOW