global Transport Knowledge Partnership

SEACAP

Southeast Asia Community Access Partnership

LOW VOLUME ROADS WORKSHOP
Napier, New Zealand, July 2009

Low Volume Rural Road Research in Vietnam on Unsealed and Sealed Roads

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REAAA Driving Progress
ROAD ENGINEERING ASSOCIATION OF ASIA & AUSTRALASIA (NZ)

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Project Need

The Ministry of Transport in Vietnam recognised an unsustainable reliance by donor programmes on unsealed gravel roads to solve the rural access problems in Vietnam.

Project Strategy

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The Rural Road Surfacing Research **(RRSR**) programme – 2 approaches:

An assessment of how unsealed gravel roads were actually performing-the Rural Road Gravel Assessment Programme **(RRGAP**)

Research into sustainable alternatives to unsealed gravel – the Rural Road Surfacing Trials **(RRST)**

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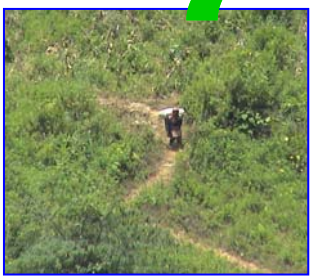
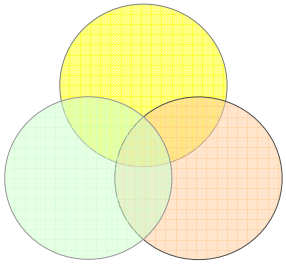
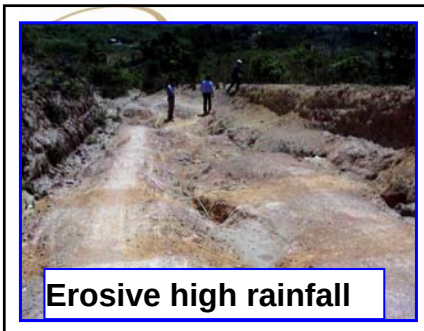




Key RRSR Aim

SUSTAINABLE RURAL ROADS

Vietnam contains some particularly challenging road environments for unpaved roads.

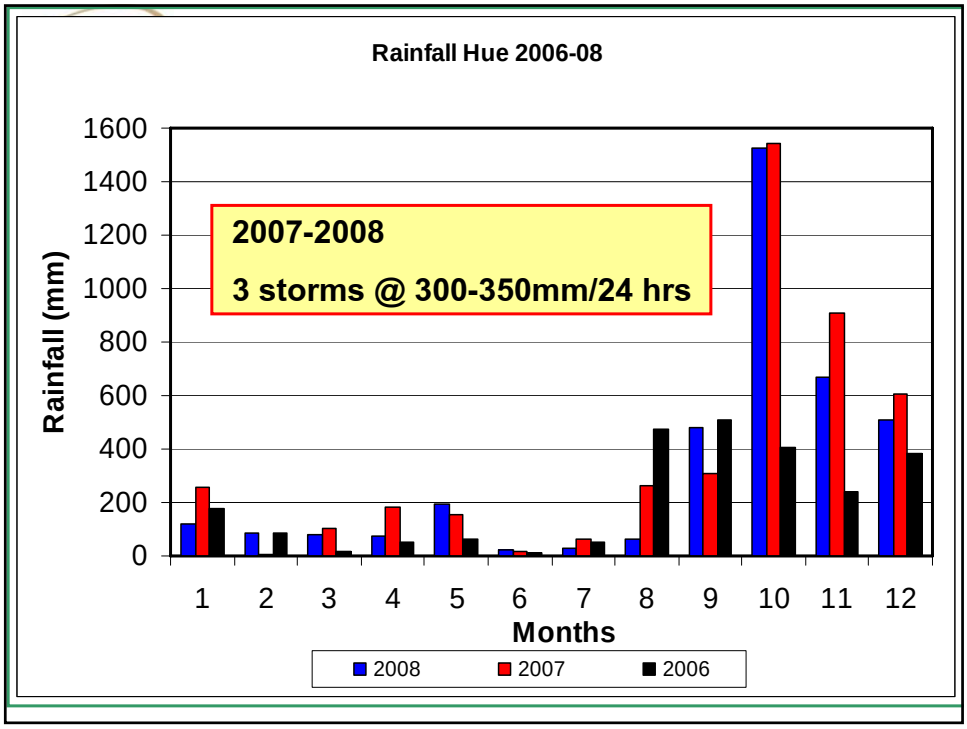


Erosive high rainfall

Variable terrain

Poor maintenance

Coastal floods



Traffic (Vietnam)

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	Vehicles Per Day		
	Motor Vehicles	Motor-Cycles	Cycles
Mekong Delta	0	1718	1085
	2	1110	646
Central Highlands	101	134	1064
	176	1150	106
	277	469	56
Northern Highlands	101	907	1025
	20	266	726
	148	1249	1304
	31	540	305
	67	572	776

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In Vietnam the SEACAP work was carried out as part of the Ministry of Transport Rural Road Surfacing Research (RRSR) programme – supported by DfID and World Bank Rural Transport Programmes 2 and 3

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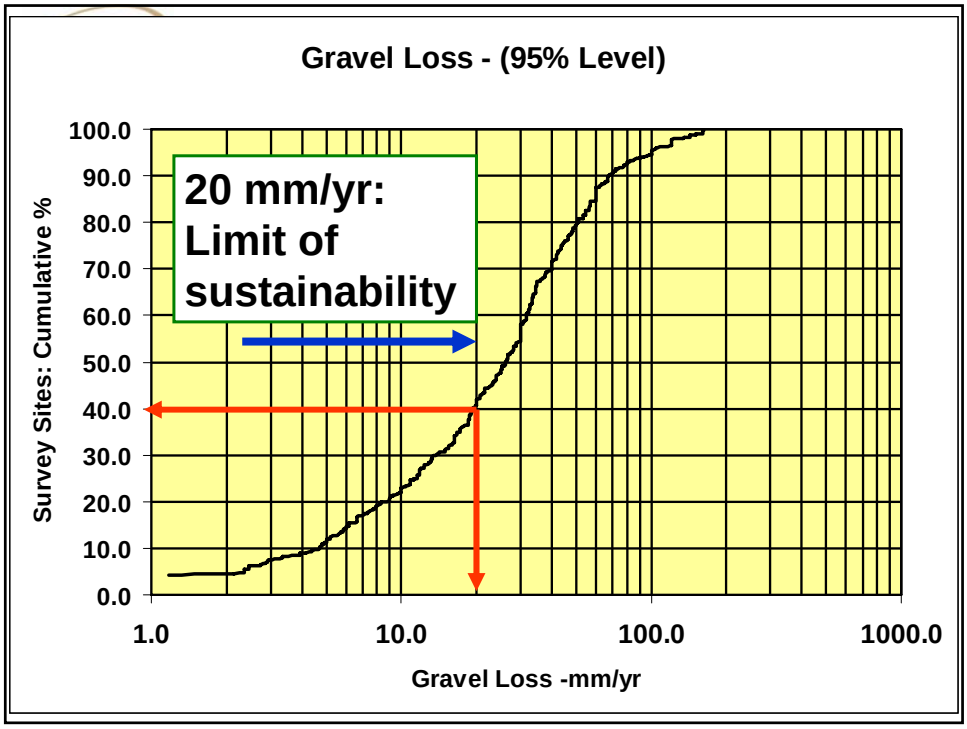
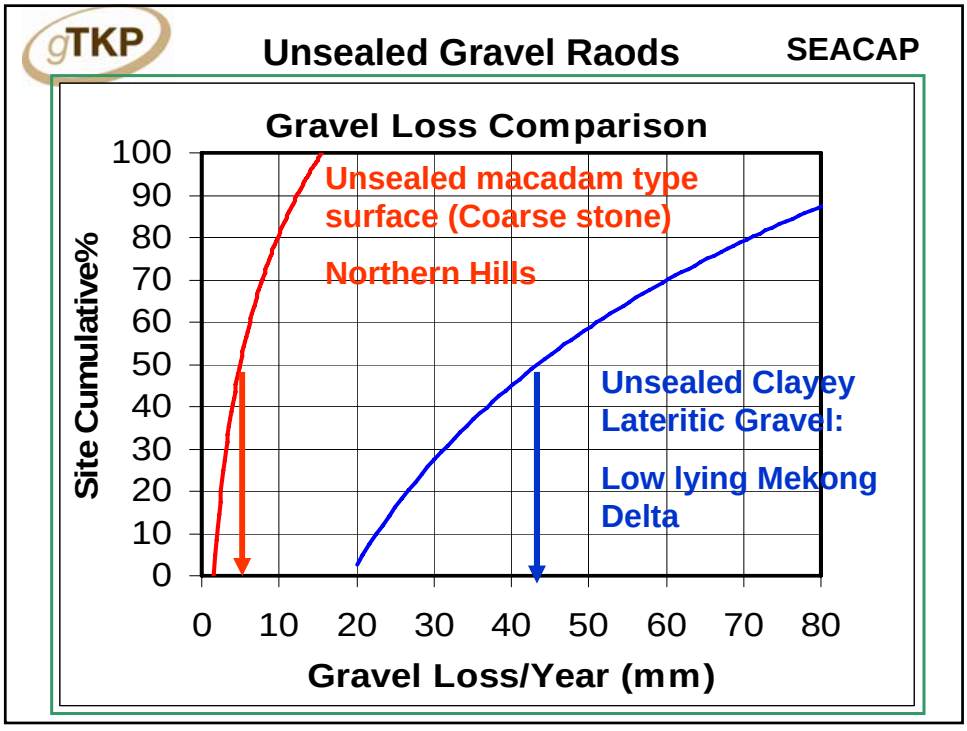
RRGAP:SEACAP 4

A snap-shot of unsealed road conditions on a representative sample of existing World Bank funded road links


Gravel Loss - (95% Level)
Survey Sites: Cumulative %
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
20 mm/yr:
Limit of
sustainability
1.0
10.0
100.0
1000.0
Gravel Loss -mm/yr


gTKP
Unsealed Gravel Raods
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Gravel Loss Comparison
Site Cumulative%
100
90
80
70
60
50
40
30
20
10
0
Unsealed macadam type
surface (Coarse stone)
Northern Hills
Unsealed Clayey
Lateritic Gravel:
Low lying Mekong
Delta
0
10
20
30
40
50
60
70
80
Gravel Loss/Year (mm)

Control Section

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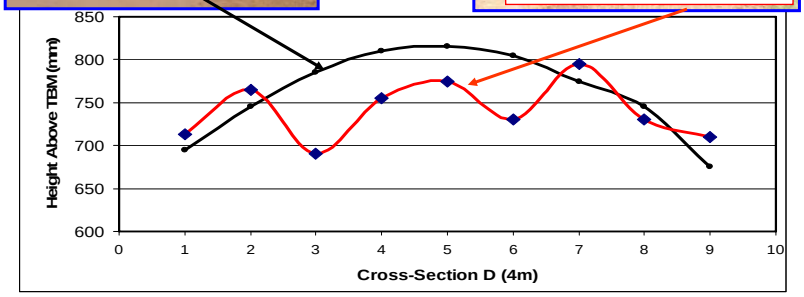
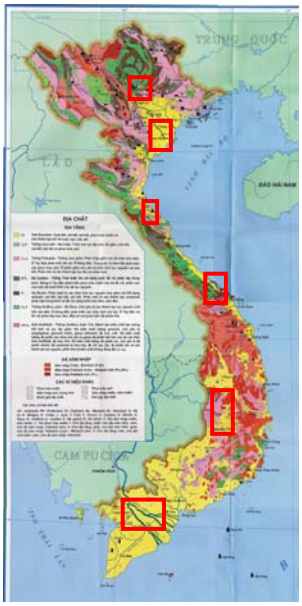


RRST I & II



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Wide Range of Pavement Material Options Trialled

- Emulsion seals
- Bitumen seals
- Unsealed gravel
- Armoured gravel
- Waterbound macadam
- Drybound macadam
- Graded crushed stone
- Cement stabilised sand
- Clay bricks
- Concrete bricks
- Cobble stones
- Quarry- run
- Bamboo RC
- Steel RC
- Non-reinforced Concrete

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Trial Selection and Design Principles

Engineering based

Appropriate to the road environments.

Local construction materials

Maintenance burden in line with local resources

Trial Options

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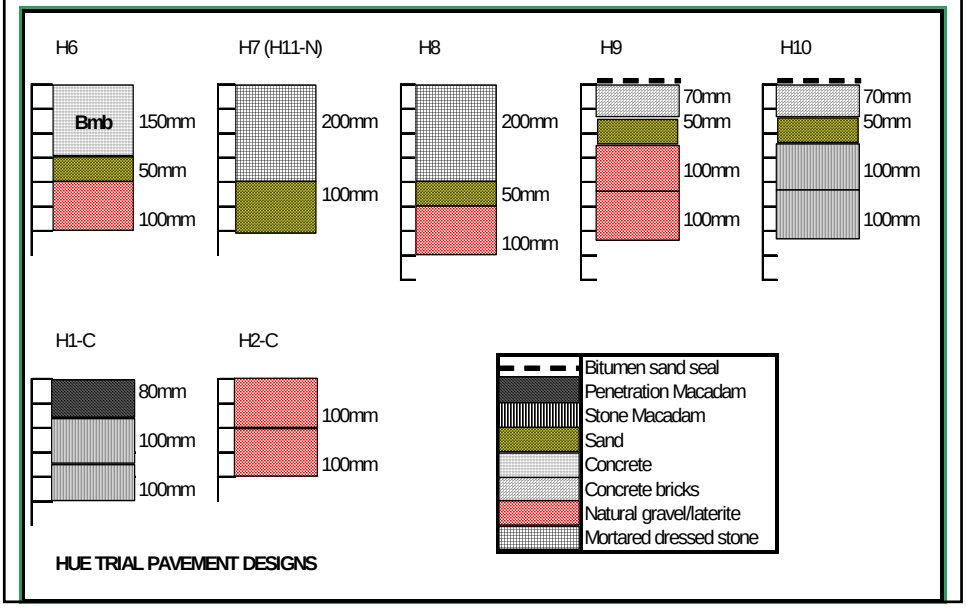

Trial Layouts

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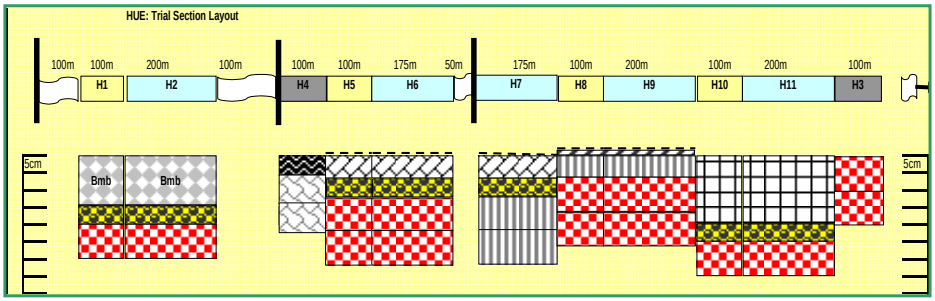

Hue

RRST- I

Road Research Delivery

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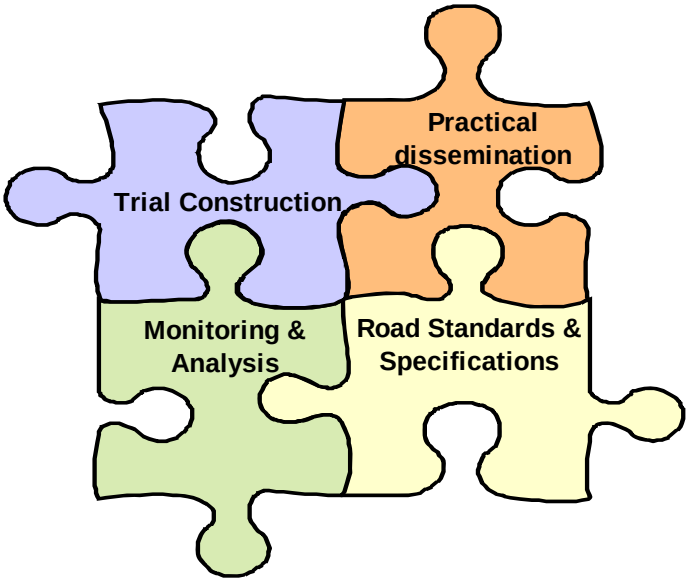

Monitoring

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Condition monitoring essential

Standard procedures (eg ORN 18)

Monitoring Summary

Roads divided into 4 categories

Trial Type	Sections	Length (km)
Block	11	1.675
Concrete	24	3.025
Sealed Flexible	56	6.300
Unsealed	16	1.670

The Road Condition Deterioration Index (RCDI)

A total deterioration index: the condition of the key factors as percentage of total deterioration (ie all visual numeric codes at their maximum defect values).
Made up of individual factor indices (CDIs)

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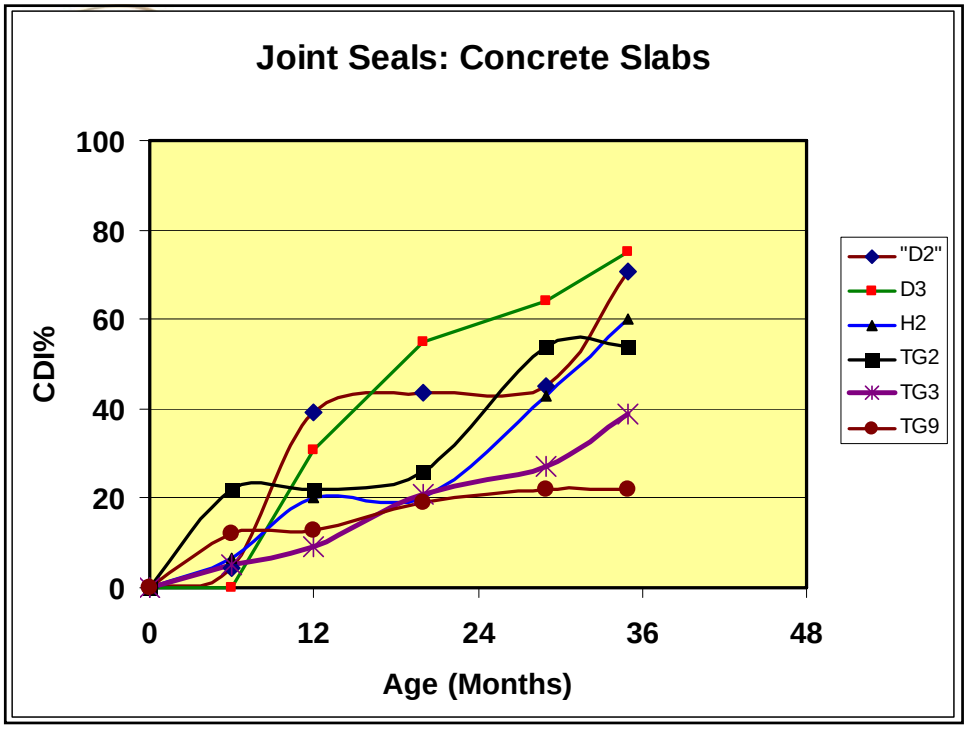
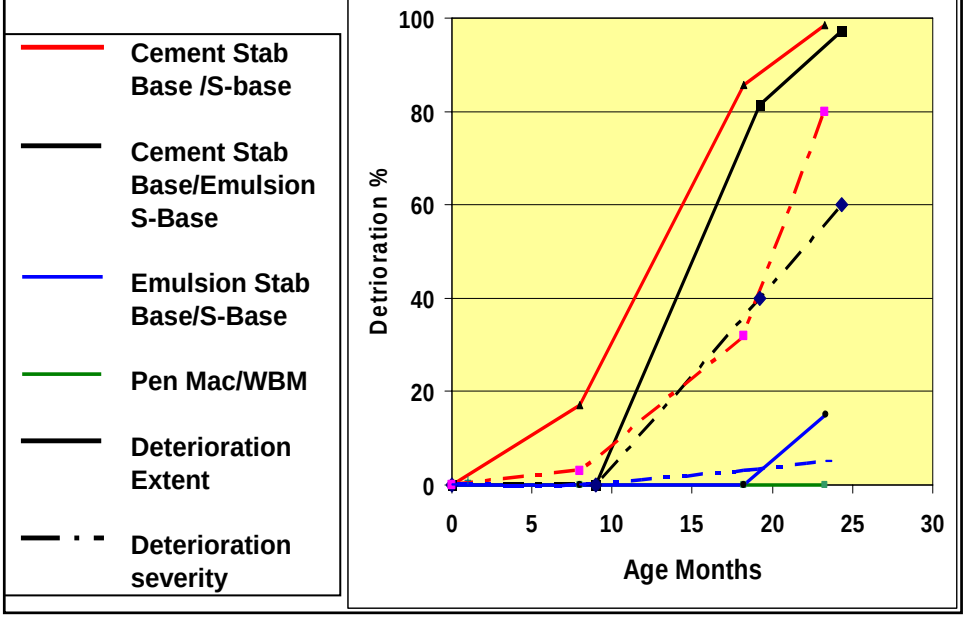
		Left Hand Carriageway								Shoulder				Right Hand Carriageway								Shoulder			
Chain	Block	Surface condition	Stone blocks	Matrix	Depressions	Ruts	Potholes	Shape	Edge	Cracks	Erosion	Run-off	Drain	Surface condition	Stone blocks	Matrix	Depressions	Ruts	Potholes	Shape	edge	Cracks	Erosion	Run-off
0	1	1	1	1	0	2	0	1	1	0	1	0	3	1	1	1	0	2	3	1	1	0	1	0
5	2	1	1	1	0	2	0	1	1	0	1	0	3	1	1	1	1	1	0	1	1	0	1	0
10	3	1	1	1	0	2	0	1	1	0	1	0	2	1	1	1	0	2	2	1	1	0	1	0
15	4	1	2	1	0	2	1	1	1	0	1	0	0	1	1	2	0	2	2	1	1	0	2	0
20	5	1	2	1	0	2	0	1	1	0	1	0	0	1	1	1	0	1	0	1	1	0	2	0
25	6	1	1	1	0	2	1	1	1	0	1	0	0	1	1	1	0	1	0	1	1	0	2	0
30	7	2	1	1	0	2	1	1	1	0	1	0	0	2	2	1	1	2	0	1	1	0	1	0
35	8	3	2	2	0	2	1	1	1	0	1	0	0	3	2	2	0	1	0	1	1	0	1	0
40	9	3	2	1	0	2	0	1	1	0	1	0	0	3	2	1	0	2	0	1	1	0	1	0
45	10	2	2	1	1	2	0	1	1	0	1	0	0	1	1	1	0	2	0	1	1	0	2	0
50	11	1	2	1	0	2	0	1	1	0	2	0	0	2	2	1	0	2	0	1	1	0	1	0
55	12	2	1	1	0	2	0	1	1	0	1	2	0	2	1	1	0	2	0	1	1	0	1	0
60	13	2	1	1	0	2	0	1	1	0	1	2	0	2	1	1	0	2	0	1	1	0	1	0
65	14	2	2	1	0	2	1	1	1	0	1	2	0	2	1	1	0	2	0	1	1	0	1	0
70	15	3	3	2	0	2	0	1	1	0	1	0	0	2	2	2	0	2	0	1	1	0	1	0
75	16	3	3	2	0	2	0	1	1	0	1	0	0	3	2	2	0	2	0	1	1	0	1	0
80	17	4	2	3	0	2	0	1	1	0	1	0	0	2	2	1	0	2	0	1	1	0	1	0
85	18	4	2	2	0	2	0	1	1	0	2	0	0	2	2	1	0	2	0	1	1	0	1	0
90	19	3	2	2	0	2	0	1	1	0	3	0	0	2	1	1	0	2	0	1	1	0	1	0
95	20	3	2	2	0	2	0	1	1	0	1	2	0	2	1	1	0	1	0	1	1	0	1	2
##	21																							



Surface Cracks Sealed Flexible Options



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MAINTENANCE COST AND ROAD CONDITION INDEX

Trial sections	Age month	Repair cost of 1km of road up to 8/2008 (USD)	Road Damage Condition Index (RDCI)		Damage Extend Index (DEI)
			Pavement	Joint	
DL(3)-1	24	1212	25	69	70
TQ(1)-2	24	624	28	28	68
DN(1)-5	24	608	17	100	53
D2	36	563	1	73	3
D3	36	537	2	76	9
DaN2	24	530	3	81	11
GL(1)-2	24	516	36	21	85
HT(1)-2	24	491	3	86	5

Block Pavements

- The single sand seals have performed poorly.
- The minimum strength requirement of 20-25MPa for manufactured engineering quality bricks is important.

- Mortared jointed options are probably more appropriate then sand joint options.
- Stone options: robust but rough

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Concrete

The results of the trials of bamboo reinforced concrete in Vietnam (together with results obtained in Cambodia) show conclusively that bamboo reinforcement in pavement slabs has no obvious advantage over well-constructed non-reinforced concrete

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Concrete

Two principal causes for poor performance stand out:

Poor quality concrete and poor support for the concrete slabs (sub-base or eroded shoulders.

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Flexible Pavements

Emulsion DBST over DBM is performing better than hot bitumen DBST over WBM.

Poor construction - major issue.

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Unsealed Gravel

The majority of gravel control sites performed poorly- however there are clearly areas where unsealed gravel surfaces are a sustainable LVRR option provided they are constructed correctly and MAINTAINED.

Unsealed WBM is not a realistic option because of loss of cohesive fines and surface loosening.

Outcomes

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The use of natural gravel as a universal rural road surface is unsustainable in the majority of the situations in Vietnam.

Other options are available that can be competitive **WLC** terms

The combination of **sustainable** gravel use and other trialled options within an Environmentally Optimised Design **(EOD)** process offers a potentially very useful way forward

EOD

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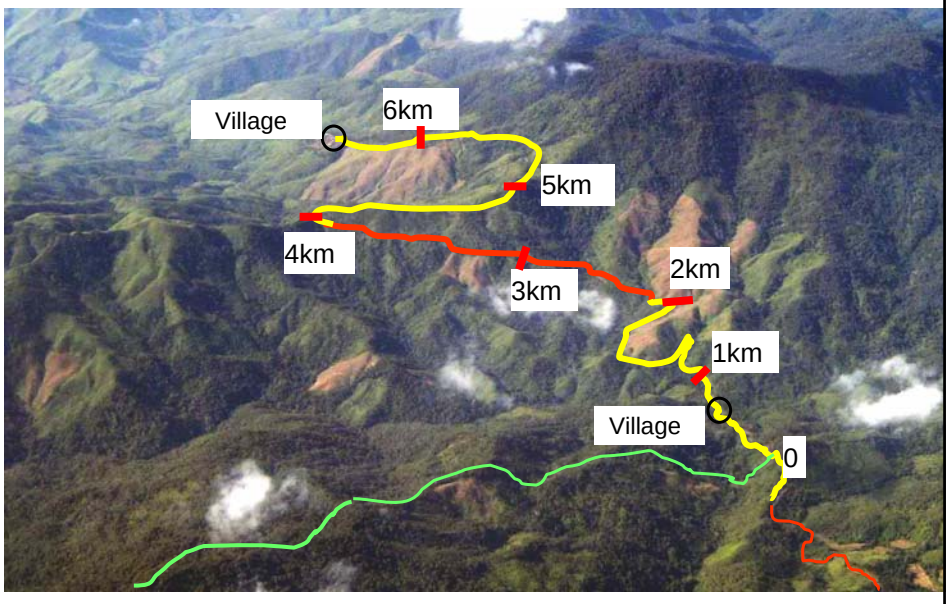

Summary

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1. Construct Trials √

2. Assess specifications & construction procedures √

3. Collect data on as-built trial condition √

4. Use information for assessing option suitability √

Summary

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5. Assess trial cots under full-scale conditions √

6. Monitor Trial performance with associated maintenance and WL costs √

7 Fully disseminate and apply to all provinces ?


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Thank You