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Local Resource Solutions to Problematic Rural Road Access in Lao PDR

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Overview

- Introduction
- Project and country background
- Aims of the project
- Trial sections constructed
- Monitoring since construction
- Discussion of results and conclusions

Introduction

- SEACAP 17 undertaken in Houay Xai, Bokeo Province in north-western Lao PDR.
- 13 short surfacing/pavement trial sections constructed on 7 different LVR.
- Low traffic volumes: roads carrying 43-210 vehicles per day excluding motorbikes.
- Low axle loads: motorbikes, tok tok and small number of cars and light trucks (<5t).

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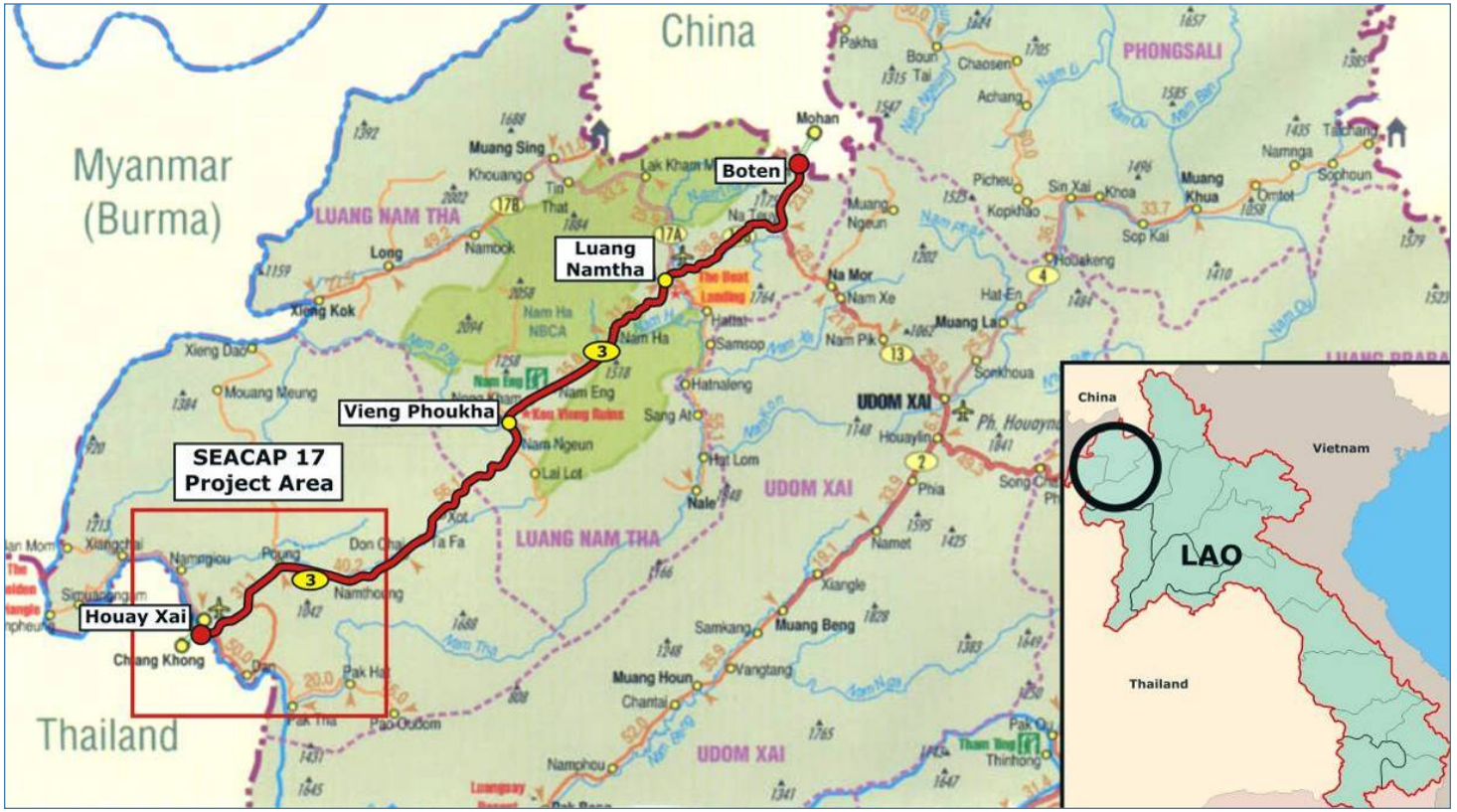
Project Location



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Why is this important?

- Rural communities need reliable access to schools, hospitals, markets and other public services.
- It is well documented by Donor agencies that improving access to road transport helps to alleviate extreme poverty.
- LVR are usually unpaved and maintenance consists of re-gravelling.
- This is an unsustainable practice and also doesn't remedy issues that cause loss of access.

Why is this important?

- Upgrading roads to paved standard is expensive, particularly when using conventional design standards and specifications.
- LVR comprise roughly 40% of the Lao PDR road network.
- Local Road Division (LRD) has enough money to maintain about one third of this network.
- We need to be innovative and develop ways to make best use of this limited funding.
- This project forms part of the attempt to evaluate and implement such methods.

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What did we want to achieve?

- Construct surfacing/pavement solutions using local materials (as much as possible) and labour-based construction methods.
- Monitor them to see which performed well, which didn't and why?
- Identify cost-effective methods of improving year-round access to rural communities in Lao PDR.
- Disseminate knowledge and findings.

Surfaces/Pavements Constructed

- Standard gravel surfacing
- Bamboo reinforced concrete slabs
- Concrete geocells
- Hand packed stone surface
- Mortared stone surface
- Concrete paving blocks
- Single sand seal
- Single Otta seal with sand seal cover
- Double Otta seal
- Engineered Natural Surface

Monitoring Process

- Visual inspections – perhaps most useful and important assessment.
- International Roughness Index (IRI).
- Dynamic cone penetrometer (DCP) & light weight deflectometer (LWD).
- Rut depth surveys on bituminous surfaces.
- Level survey to monitor gravel loss.
  - Limited success; visual survey better.
  - Highly dependent on locating same points each time.
- Sand patch tests on bituminous surfaces to assess surface texture.

Results – Otta Seals (1)

- Seals constructed with thick layers of binder and natural gravel aggregates.
- Both surfaces in good condition without having received any maintenance.
- Images below for single Otta with sand seal. Double Otta seal visual performance is similar.

Results – Otta Seals (2)

- DCP tests showed reduction in base layer strength:
  - CBR of 36% under single and 49% under the double seal – very low!
  - These are at in-situ density and moisture content. Soaked CBR can be expected to be much lower. Do we need soaked CBR?
- Moderate rutting on both sections ranging from 10 – 30mm.
- Despite this the serviceability level is still high - ultimately the road still serves its purpose at this stage.
- Rate of deterioration to increase due to lack of maintenance.
- This will lead to further moisture ingress and ultimately pavement failures.

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Results – Sand Seal (1)

- The seal has completely deteriorated. Deterioration started about 1 year after construction.
- It is a single seal which by its nature lacks durability.
- Not suited where maintenance capacity is low.

Results – Sand Seal (2)

- Main issue with this section is durability of the surface rather than structural performance of the pavement.
- IRI highlights the deterioration in serviceability in recent years.
- As per Overseas Road Note 5, an IRI of 12.9 on a paved road corresponds with 'severe disintegration' as seen here.

Road	Section	IRI (m/km)		
		Base Line (2007)	Feb 2009	Oct 2012
8.0	Sand Seal	6.5	5.0	12.9

Results – Bamboo Reinforced Concrete and Concrete Geocells (1)

- Bamboo reinforced concrete performing well with only a small number of slabs showing cracking at the corners.

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Results – Bamboo Reinforced Concrete and Concrete Geocells (2)

- Concrete geocells also in very good condition. Exhibiting some edge break on the top of individual cells.
- Excellent serviceability levels on both surfaces.

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Results – Stone and Block Surfaces (1)

- Hand packed stone and mortared stone both continue to provide year-round access.
- Surfaces are very rough and disliked by road users.

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Results – Stone and Block Surfaces (2)

- Concrete paving blocks are performing very well.
- Only issue is a small number of areas with missing or dislodged blocks.
- Can be maintained using locally produced blocks.

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Results – Stone and Block Surfaces (3)

- IRI confirms very rough condition of the stone surfaces.
- Anecdotal evidence in Lao PDR and similar sections in Tanzania of discomfort, vehicle damage and falls from bicycles.
- No issues with concrete paving blocks. They provide excellent serviceabilty levels.

Road	Section	IRI (m/km)		
		Base Line (2007)	Feb 2009	Oct 2012
2.0	Hand Packed Stone	6.6	9.6	18.7
3-2	Mortared Stone	14.3	15.7	17.7
5.0	Conc. Paving Blocks	9.1	6.0	6.3

Results – Gravel and Earth (1)

- Performance satisfactory on flat, well drained sections.
- All sections still permit year-round access.

Results – Gravel and Earth (2)

- Rutting, erosion channels and general gravel loss on all sections - gravel has been lost from most sections.
- Research from Vietnam[9] indicates gravel not suited to gradients greater than approximately 6%.
- IRI generally indicates an increase in roughness since 2009. Ride quality comfortable at speeds of 50 km/hr or less.
- Still providing access which is the main goal, but require maintenance.

Construction Costs

- Gravel surface had the cheapest construction cost at about $\$2.50/m^2$ – as expected.
- Bituminous seals range from approx. $\$6.00$ to $\$9.00/m^2$.
- Paving blocks cost approx. $\$30.00/m^2$ due to error in contractors pricing. Should have cost no more than $\$14.00/m^2$.
- Hand packed and mortared stone both cost $\$6.00/m^2$
- Concrete most expensive: $\$15.00\text{-}33.00/m^2$ depending on thickness and use of geocells.

Whole-Life Cost

- Hand packed stone and mortared stone are the most cost-effective options.
- Gravel and earth is cost effective only in flat and straight (i.e. low stress) areas.
- In hilly areas, bituminous seals and concrete paving blocks are more cost effective.
- The initial capital costs of concrete pavements is high and this makes them difficult to economically justify even in the long-term.

Discussion/Conclusions (1)

- The project has shown that some engineered pavements can provide more economical alternatives to re-gravelling.
- They help provide year-round access to rural communities and make better use of limited funding.
- Consideration must be given to local maintenance abilities when choosing the appropriate solutions.
- For example, the need for bitumen and specialist equipment versus locally available bricks or blocks.
- Getting this right makes maintenance easier and increases the likelihood of it occurring.

Discussion/Conclusions (2)

- Use of sand seal is discouraged unless there is an efficient maintenance operation in place.
- Hand packed stone and mortared stone should generally be avoided where possible, even though they are cost-effective.
- Strongly disliked by road users who are driving on the shoulders instead.
  - Evidence of vehicle damage and falls from bicycles on the project in Tanzania, where the surface is also strongly disliked.
- Concrete pavements performed very well but have the highest overall costs. They will be difficult to justify in reality.

Discussion/Conclusions (3)

- Otta seal performance indicates soaked CBR may be overly conservative.
- Highlights the fact that many **suitable** materials get overlooked because they don't comply with **unsuitable** specifications.
- We need to promote and develop new design approaches and specifications such as DCP design as trialled in Tanzania.
- These are necessary to enable better use of local materials that are perfectly suitable for LVR construction.

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Thank you

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