SEACAP 019 - 03

Development of Local Resource Based Standards

TRL Limited

in association with OtB and

KACE

Team

Dr John Rolt (TRL)

Dr Jasper Cook (OtB)

Heng Kackada (KACE)

Terms of Reference - Outputs

- Classification of LVRRs with geometric specifications
- Guideline document
- Matrix of pavement and surfacing options
- Presentation of the above

Factors affecting geometric standards

- Cost
- Terrain
- Traffic
  - Volume
  - Composition
- Land use – through village or open country
- Safety
- Pavement type

Terrain

- In hilly and mountainous terrain we cannot afford to build roads to the same standards as in flat terrain
- The reduction in standards is based on cost but also largely on judgement

What is a ‘standard’

What do we mean by a standard -

For each road classification the standard is the minimum that is considered acceptable

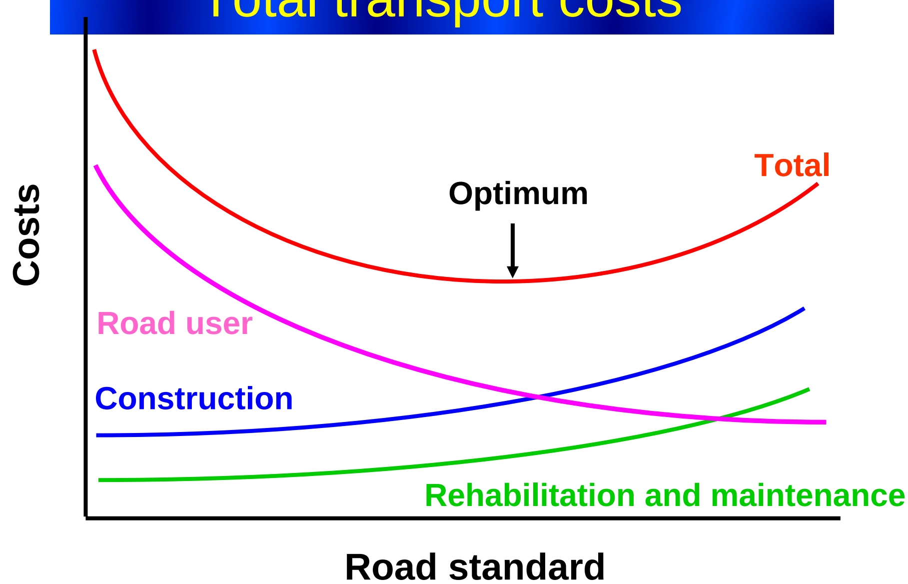
Higher standards can be selected if required but not lower standards

Exception – mountainous terrain where there is often no choice but to reduce standards

Traffic volume and composition

- For high traffic levels, higher standards are justified
  - Traffic will travel faster,
  - Journey times will be shorter
  - Vehicle operating costs will be lower

Total transport costs



Traffic volume and composition

- For high traffic levels, higher standards are justified
  - Traffic will travel faster,
  - Journey times will be shorter
- Vehicle operating costs will be lower
- Methods of calculating operating costs and determining optimum standards have been developed but are not applicable to low volume rural roads

Traffic (continued)

- Standards depend on the largest vehicles that the road is to carry. If the vehicles are small, lower standards can be used (for the same traffic level)
- Usually based on numbers of 4-wheeled vehicles per day

Design traffic

- The traffic for design is that which is estimated to be using the road in mid-life, namely in about 7 years from construction or upgrading.
- A general growth rate is assumed or is provided by government based on the growth in registered vehicles during previous years.
- Local development plans may indicate higher growth rates in some places.

Safety and land use

- Where required, safety features should be included
  - For example – wider shoulders, speed reducing features
- Where pedestrian numbers are high (schools, markets, houses) the road standards need to be different (higher) to accommodate the activities and for safety

Pavement type

- Essentially surfacing type - unpaved (gravel, earth) and paved
  - Affects friction, maximum traffickable gradients, stopping distances, and overall vehicle control (safety)

Political

- The administrative function of a road sometimes controls the standards adopted.
- The factors discussed above should control standards but it may be necessary to define separate minimum standards based on administrative function to satisfy government requirements

Summary - factors affecting geometric standards

- Cost
- Terrain
- Traffic
  - Volume
  - Composition
- Land use – through village or open country
- Safety
- Pavement type

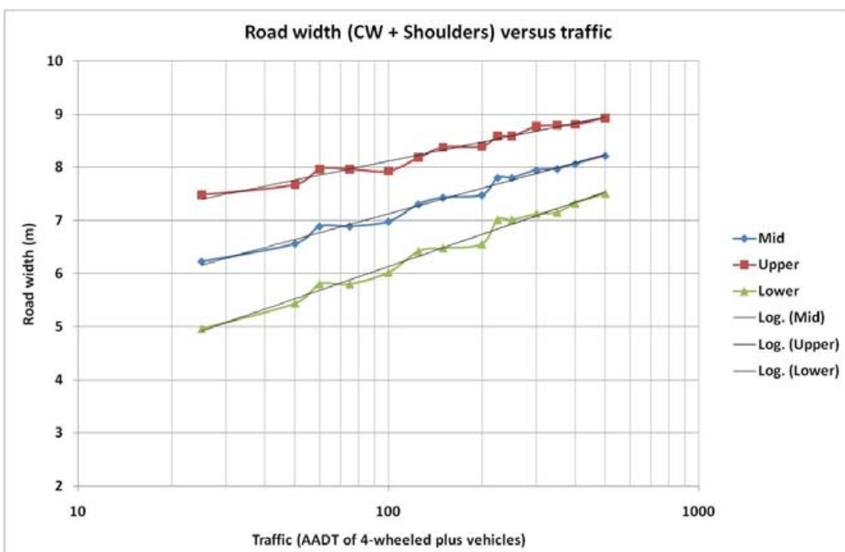
Two key features

- Road width
- Design speed – many aspects of the geometric standards are directly related to design speed
  - For example, curvature of the road and the distance that a driver can see ahead to stop safely (to avoid colliding with an object that should not be there)
- Lower design speed = less expensive road

International Standards for LVRR

- ARRB (Australia)
- South African Roads Board
- ORN 6 TRL (Overseas Road Note 6)
- Lao
- Thailand
- Southern Africa Transport and Communications Commission
- Swedish International Development Agency Secondary and Feeder Road Development Programme
- Zimbabwe, Kenya and Tanzania
- World Bank

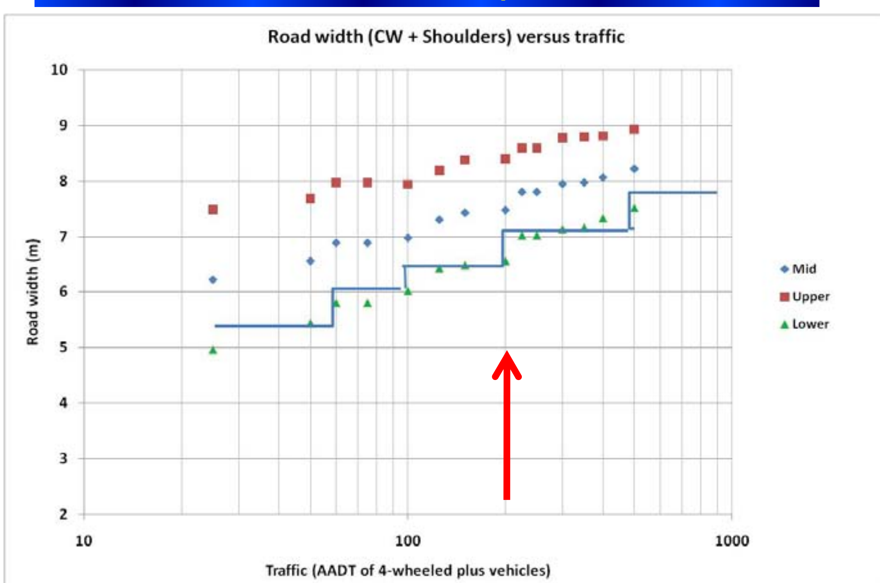
Road width comparisons (CW + shoulder)



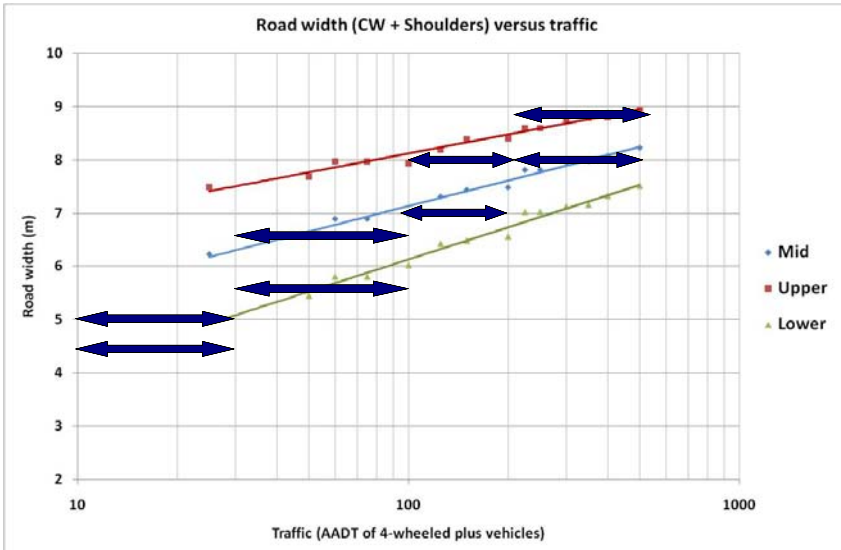
Design vehicle

- Typically
  - Width = 2.5 or 2.6m
  - Length = 9.5 to 11.0 m
  - Front overhang = 1.2 m
  - Turning radius = 13 m

Road width comparisons



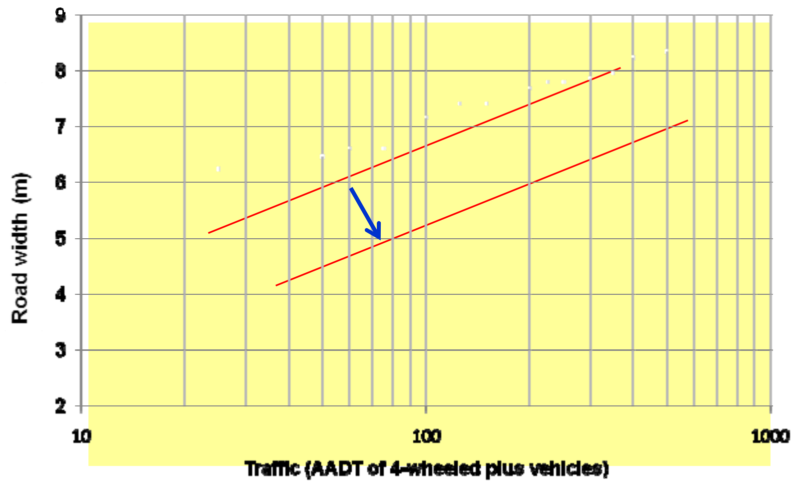
Proposals



Proposed classification

Class	AADT of 4-wheeled vehicles	Width of running surface (m)	Sub class	PCUs of non 4-wheeled vehicles	Width of shoulders (m)	Total width (m)
RR 1	200 to 500	6.0	A	>300	1.5	9.0
		6.0	B	< 300	1.0	8.0
RR 2	100 to 200	5.0	A	> 300	1.5	8.0
		5.0	B	< 300	1.0	7.0
RR 3	30 to 100	3.5	A	> 300	1.5	6.5
		3.5	B	< 300	1.0	5.5
RR 4	5 to 30	3.0	A	> 300	1.0	5.0
		3.0	B	< 300	0.75	4.5
RR 5	< 5	2.5	A	>300	1.0	4.5
		2.5	B	<300	0.75	4.0

Designing for smaller vehicles



Recent study in Lao

- A design vehicle of 1.8 - 2.3m width was assumed for LVRRs
- This allowed the overall road width to be reduced to 5.5m for a single carriageway road
- For the lowest class of road, a design vehicle width of 1.8m was used. For low levels of non-motorised traffic, a road width of 4.5m was selected.

Structural design for higher traffic

- The structural design of roads that do not fall into the low volume category (< 200ADT) differs significantly from that of LVRRs
- Material standards are higher
- Thickness designs are higher
- Not covered in this project

Design speed

- Sight distances (curves, crests) required for
  - safe stopping (objects in road, approaching vehicles)
  - safe overtaking
  - (and drivers comfort)
- Maximum horizontal curvature
- Design of crest curves
- Crossfall

Design speed (km/h)

Classification	Flat	Rolling	Mountainous
Rural Road RR 1	60	50	40
Rural Road RR 2	50	40	30
Rural Road RR 3	50	40	30
Rural Road RR 4	50	40	30
Rural Road RR 5	30	30	20

Stopping sight distances

Design speed (km/h)	30	40	50	60
Stopping distance (m)	25-35	35 -55	50 -75	65-100
Recommendations (unsealed)	35	50	70	95
Recommendations (sealed)	30	40	50	65

Minimum radii of curvature

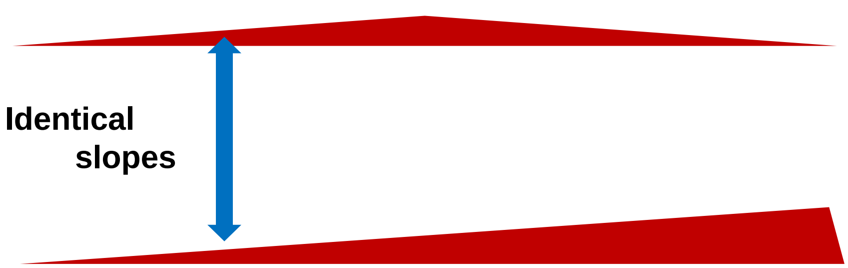
Sealed roads

Design speed (km/h)	**30**	**40**	**50**	**60**
Minimum horizontal radius for SE = 4%	32	59	97	150
Minimum horizontal radius for SE = 7%	20	39	70	112
Minimum horizontal radius for SE = 10%	18	35	63	97

Unsealed roads

Design speed (km/h)	**30**	**40**	**50**	**60**
Minimum horizontal radius for SE = 4%	35	67	110	165
Minimum horizontal radius for SE = 7%	31	60	100	150

Removal of adverse camber



Adverse camber and super-elevation

- The maximum recommended side-slope/crossfall on unsealed roads is 6%
- This is equal to the recommended design camber hence no greater slope is ever recommended
- For sealed roads the recommended camber is 3-4% but higher values of cross slope up to 7% (10%) are OK hence, where needed, super-elevation is recommended

Maximum gradient

- Flat 6%
- Rolling 8%
- Mountainous 10%
  - (short sections up to 15% allowed)

Note maximum on gravel roads = 6%

- In

Matrix of structural designs

- Some structures will naturally last longer than others and some will be better suited to particular conditions.
- In principle, the least cost option that is available in a particular location should be selected based on whole life costs

SEACAP road trials

- Mainly 140 km of roads in Vietnam.
- The performance of the trial roads are being analysed in order to..
  - understand how and why the deterioration of each type of structure is taking place,
  - to determine the factors on which it depends,
  - to quantify the effects so that the behaviour of the roads can be predicted, and
  - to determine the vital factors that need to be controlled to achieve adequate performance in different situations.

SEACAP road trials

Although the research is ongoing there is sufficient evidence to identify the most effective solutions and, just as importantly, those that should not be used until more evidence is available of long-term performance.

6 types of surfacings

- Gravel
- Surface dressings and Otta seals
- Penetration Macadam
- Concrete
- Concrete blocks
- Dressed stone

4 types of road bases

- Water Bound Macadam
- Dry Bound Macadam
- Graded Crushed Stone
- Chemical (lime, cement) Stabilized roadbases

Plus

Gravel sub-base

Four basic structures

Layer	Structure 1	Structure 2	Structure 3	Structure 4
Surface	Gravel	DBST or Otta	Pen Mac	Concrete
Road base		WBM, DBM, GCS, Stabilised	WBM, DBM, GCS, Stabilised	-
Sub-base		Gravel	Gravel	Gravel
Selected Fill[1] where required		CBR > 10%	CBR > 10%	CBR > 10%

Traffic 1

- There is very little information available about the traffic on the rural roads
- For design, information is required on types and volumes of traffic and the loads carried by the largest vehicles

Traffic 2

- Assumptions have been made based on the best evidence
- Traffic counts are assumed so that the correct class of road can be selected
- Two load scenarios have been defined

Load scenarios

- Low = 20% heavy vehicles with average esa values of 1.0 esa per heavy vehicle.
- High = 20% heavy vehicles with average esa of 5.0 esa per heavy vehicle

Structural options

Class	ADT (sum of both directions)	Cumulative mesa (one direction)	
		High load option	Low load option
RR 1	200 - 500	1.3	0.5
RR 2	100 - 200	0.5	0.1
RR 3	30-100	0.25	0.05
RR 4	5 - 30	0.1	0.02
RR 5	0 - 5	0.02	Very low

Structural options

- Thus structural designs are needed for traffic levels of 0.02, 0.05, 0.10, 0.25, 0.50, and 1.3 mesas,
- Six traffic options altogether

Subgrade

- The other principle parameter is subgrade strength
- Six strength categories have been defined based on CBR.

S1 = 2%, S2 = 3, 4%, S3 = 5 - 7%

S4 = 8 -14%, S5 = 15 - 29%, S6 = >30%

Outcome

- Thickness designs for all the combinations of surfacings and roadbases are not all different (e.g. WBM, DBM, GCS are essentially the same)
- A total of six basic design charts have been developed
- Each chart contains 6 cells for subgrade and 6 cells for traffic hence each comprises 36 designs.

Future developments

- Additional design charts and improvements will be possible when the research studies have been completed .