AFCAP
African Community Access Programme

BRIEFING NOTE

AFRICA-UK ENGINEERING FOR DEVELOPMENT PARTNERSHIP TRAINING WORKSHOP ON RURAL TRANSPORT AND DEVELOPMENT ARUSHA, TANZANIA – 29 TO 30 NOVEMBER 2010

1. ECONOMICS OF RURAL ROADS AND RURAL ROAD TRANSPORT

a) There is a strong case for investments in rural roads and rural road transport in Africa. Social and economic development and attainment of the Millennium Development Goals depend on reliable access to rural areas and mobility of the rural population. A competitive transport service supports agricultural marketing, providing access to urban and international markets. The price and availability of transport affects the nature, quality and accessibility of social facilities such as schools, clinics, hospitals, and water supply.

b) Within the village, transport activities for collecting water, firewood and going to the farm consume significant labour time and effort. In many countries this burden is carried mainly by women and children.

c) Poor transport services in rural areas are a visible manifestation of poverty. Rural transport is characterized by high personal effort, long-distance trip making, low goods movement, limited modal choice, high transport costs, poor service frequency, and unsafe transport. This is due to low density of demand, poor infrastructure funding and weak institutional structures. Transport costs are high in Africa compared with other parts of the World.

Oxford University carried out a study in six villages (354 households) in south and central Ethiopia between 1989 and 1994. The study found that the presence or absence of a road was a major factor in reducing poverty. Food consumption rose by 8% per year in this time and poverty declined in all but one village. Over 50% of the change was attributed to road infrastructure and location.

d) Rural areas are poor and have a very low tax base. Traffic volumes are low hence maintenance costs per vehicle kilometre are high. If Road Funds are the key source of finance for road maintenance, cross subsidies from main and urban road traffic are inevitably required.

e) Road investments on their own may not be enough to ensure mobility for rural communities. A conducive environment is needed to support the development of transport services operating on the road networks. Government policies on rural transport need to recognise the importance of all transport modes, including the needs of pedestrians, cyclists and other non-motorised transport.

f) In Africa there is a lesser use of **Intermediate Means of Transport** (IMTs) than in parts of Asia. IMTs include bicycles, motorbikes, carts, carrying poles, tractors and animal transport. Most IMTs are introduced and sustained by the commercial sector with little external help. Some government/ donor initiatives have introduced IMTs to rural populations, but with mixed results. Initiatives have generally taken the form of demonstration examples with associated credit and training. Critical factors are a) The need for a sufficiently large number of adoptions to secure wider acceptance and viable repair and maintenance b) The ability of the user to earn a cash income from the IMT.

2. THE PLANNING AND PRIORITISATION OF RURAL ROADS

a) The objective of economic analysis of rural roads is to establish the following: Is the road investment justified? Are the benefits of the project greater than the costs? Which is the best investment if there are a set of mutually exclusive alternatives? If funds are limited, how should different schemes be ranked? When should the road be built? What standards should be applied? Are complementary investments required to make the project viable?

b) There are a number of tools that can be used to prioritise road investments. These tools consider the direct costs of road investments as well as primary and secondary effects. They include the consumer surplus approach, the producer surplus approach, indices and ranking, and community priorities.

c) **Transport User-Cost Analysis** is the most versatile and most frequently used method of road planning. This method involves a comparison between costs and benefits. Costs include management, manpower, machinery, materials, land acquisition, and environmental mitigation. Primary effects (benefits) include: reduced vehicle operating costs, reduced journey times, changes in road maintenance costs, changes in accident rates, increased travel, environmental effects, and changes in the value of goods moved. Secondary effects include changes in agricultural and industrial output and services, changes in consumer behaviour, and changes in land values.

d) **Community Priorities** are an important part of rural access road appraisal. Communities are asked to rank the investments they prefer, both within the road sector or between roads and other investments. The participation of the community at an early stage in the project has benefits for later implementation. Communities often have important local knowledge that is not apparent to outsiders. A disadvantage is that the prioritisation process can be dominated by sectional interest groups.

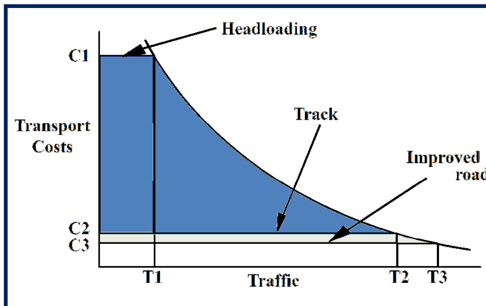


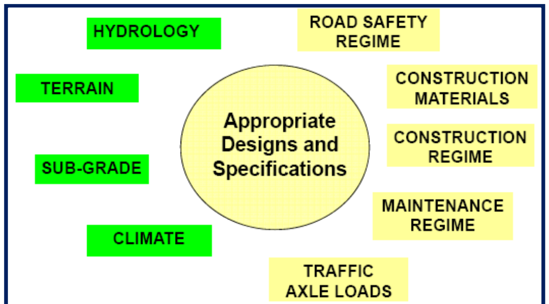
Illustration of Benefits from Building a Track or an Improved Road

e) Research in Africa has shown that high economic returns are derived from investments in basic access for communities. In many cases basic access can be achieved at relatively low cost through a spot improvement approach. Speed of travel is less important for rural communities than the guarantee of arriving safely at their destination. A minimum investment approach often gives the best economic results.

f) At higher traffic levels there are benefits from providing a sealed road surface rather than traditional gravel roads. Research in Zimbabwe showed that sealing of rural roads could be economically justified at traffic levels as low as 40 vehicles per day, though it was noted that Zimbabwe has a dry climate, poor availability of good surfacing gravels, and (at the time) low construction costs.

3. PRINCIPLES FOR THE DESIGN OF LOW VOLUME RURAL ROADS

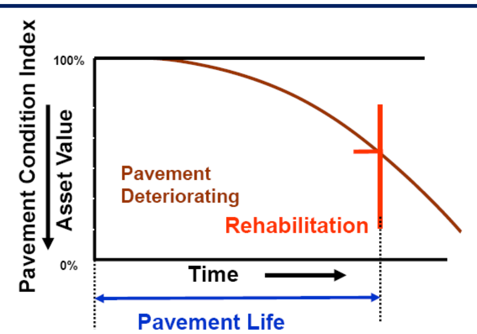
a) By definition, LVRs carry less than 150-200 motor vehicles per day with up to 6 tonne axle loads, and less than about 250,000 equivalent standard axles over the design life.



The Road Environment

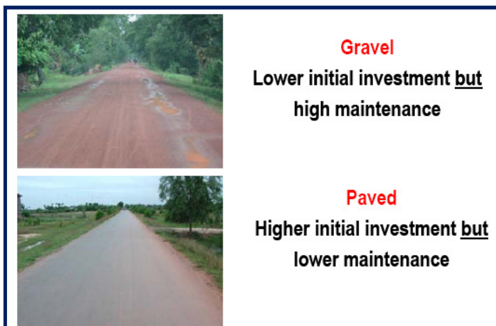
b) The performance and design of Low Volume Roads (LVRs) is not wholly governed by the traditional design factors of traffic and sub-grade (natural ground) strength. Pavement selection and design must take into account a much wider range of factors known collectively as the **Road Environment**.

c) Rural Roads should be "**Task Based**" – i.e. they should suit the road function and its traffic. Rural roads should be compatible with the provincial engineers who design them, the contractors who construct them, the agencies that maintain them, and the construction materials that are available locally. The construction of roads should not exhaust provincial and district budgets or place excessive maintenance burdens on local communities.



All Roads Have a Design Life

d) All road pavements have a design life. Sealed pavements normally have a design life of at 10-12 years or more. The design life of gravel roads is variable and is dependant the management of the road.

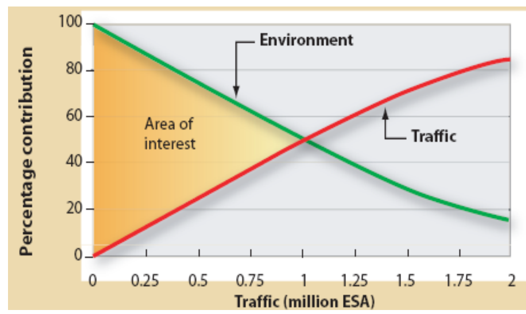


Example of Whole Life Costing

e) Alternative design options for roads should be compared using **Whole Life Costing.** This is a process of assessing all costs associated with a road investment over its intended lifetime, which include construction, maintenance, and vehicle operating costs. The residual value of the asset at the end of the assessment period is also taken into account. A discount rate is usually applied to future costs and benefits.

f) Most rural roads have a standard design along their entire length. However, significant cost savings can be achieved by reducing the design level, where possible, in response to changes in the road environment. **Environmentally Optimised Design** provides a spectrum of solutions for improving or creating low volume rural access, from dealing with individual critical areas on a road link to providing a total whole rural link design. **Spot Improvements** involves the improvement of identified road sections deemed to be at high risk of failure, and allows the appropriate application of limited resources.

g) A good **Road Drainage System** is vital to the successful operation of a road. A good road drainage system must convey rainwater away from the carriageway, control the level of the water table, intercept surface water flowing towards the road, and convey water across the line of the road where necessary. The basic costs of protecting a road from the effects of water are largely independent of traffic. For LVRs, the cost of the drainage system can comprise a large proportion of the cost of the road.



Traffic loading versus dominant mechanism of deterioration

h) For a correctly constructed pavement carrying low levels of traffic, there is a low risk of a pavement failure being induced by traffic. Deterioration is controlled mainly by environmental factors.

4. CLASSIFICATION AND GEOMETRIC DESIGN OF LOW VOLUME ROADS

a) The **Classification** of low volume roads should comprise a logical grouping of roads based on task or function. The system should allow each group to be treated in a similar way regarding engineering design, construction and maintenance.

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

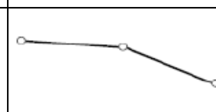
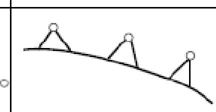
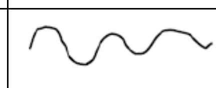
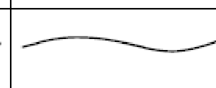
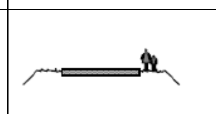
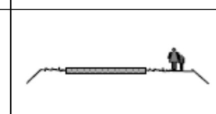
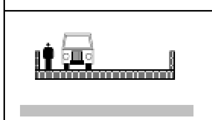
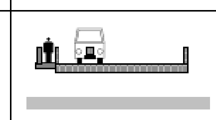
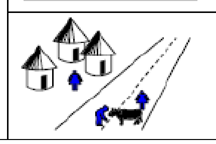
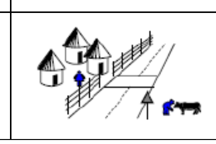
Typical Road Classification System

b) A **Standard** is a specific nationwide level of service that should be achieved at all times and ensures consistency across the country. Road users know what to expect and drivers are not surprised by unexpected changes. For each road classification the Standard is the minimum level of service that is considered acceptable. Higher standards can be selected if required but not lower standards, except in mountainous terrain.

c) **Geometric Design** is the process whereby the layout of the road is designed to meet the needs of the road users. The geometric design must be economical and provide a minimum acceptable level of safety. Geometric standards are affected by terrain, traffic and land use. In hilly and mountainous terrain it is more expensive to build roads to the same standards than in flat terrain. The largest vehicle that is expected to use the road regularly determines the overall width of the running surface. A road carriageway or its shoulders might be widened through a village to cater for pedestrians.

d) **Design Speed** is normally defined as the maximum safe speed that can be maintained over a specified section of road when conditions are such that the design features of the road govern the speed. The concept of design speed allows the key elements of geometric design to be selected for each standard of road in a consistent and logical way. These include sight distances required for safe stopping (on curves and crests), maximum horizontal curvature and appropriate cross-fall.

e) Experience has shown that adopting design standards from developed countries does not necessarily result in acceptable levels of safety on LVRs. Roads in developing countries carry a different mix of traffic, including relatively old, slow-moving and overloaded vehicles, a large number of pedestrians, bicycles, animal drawn carts and motorcycles. Traffic speeds should be reduced in these mixed traffic environments, rather than aiming for higher design speeds, as is the case for major roads.

	Undesirable	Desirable	Principle Applied
Route Location			Major routes should by-pass towns and villages.
Road Geometry			Gently-curving roads have lowest accident rates.
Segregate motorised and non-motorised traffic.			Seal shoulder and provide rumble divider when pedestrian or animal traffic is high.
			Construct projected footway for pedestrians and animals on bridges.
			Fence through villages and provide pedestrian crossings.

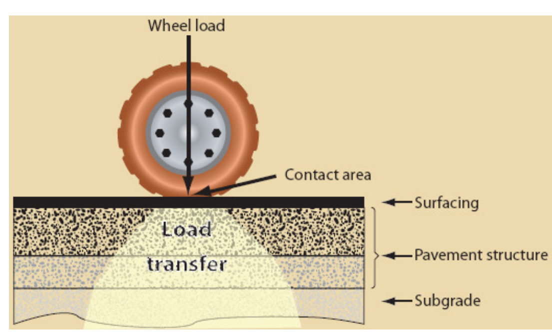
Some Safety Recommendations

5. DESIGN OF PAVEMENTS AND SURFACINGS FOR LOW VOLUME ROADS

a) The purpose of road design is to allow the road to perform a Task in a defined Environment and within an affordable Budget. "Over-design" and "Under-design" of roads should both be avoided.

b) A road pavement has both functional and structural requirements. It should serve traffic safely, comfortably and efficiently at reasonable cost. It is also a load bearing structure that is required to perform under the prevailing traffic and environmental conditions with minimum maintenance.

c) The selection of the pavement type and surfacing should follow a two phase approach:



Spread of Wheel Load through Pavement Structure

- Phase I: Identification of appropriate pavement and surfacing types compatible with the road environment.
- Phase II: Detailed design of the selected pavement components (layer thicknesses) and the surfacing in accordance with accepted national design standards.

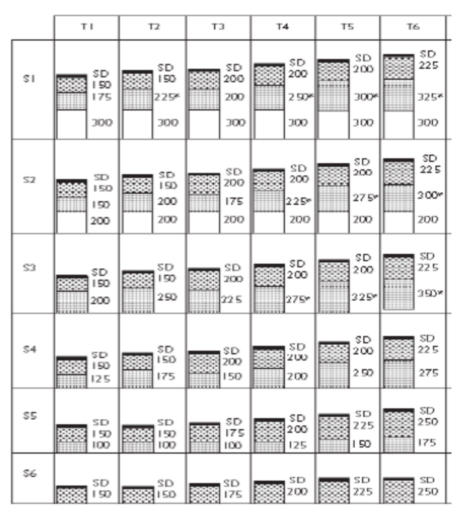
d) Most rural roads in Africa have an unsealed earth and gravel surface. These roads are appropriate for low traffic volumes where an appropriate maintenance regime is in place. Gradients should be less than 4% in medium rainfall areas and less than 6% in low rainfall areas. Where these conditions are not met consideration should be given to providing a more durable surfacing.

Some Surfacing Options for LVRs

e) An understanding of the road environment is achieved through **Site Data Collection**. Site data includes the history and condition of any existing road on the alignment, traffic levels, drainage conditions, strength of the existing pavement, and availability of materials.

f) Simple traffic count procedures have been developed which are suitable for LVR design. They involve the use of simple field data forms followed by the adaptation of the counts into equivalent **Average Daily Traffic**.

g) An understanding of locally available materials is the key to sustainable rural road construction. Appropriate road construction materials are selected on a “fitness for purpose” basis. Specifications and designs must be suited to local materials. Materials should be appropriate to their intended role, neither sub-standard nor wastefully above the standards demanded by their engineering task. Materials testing should define service performance in terms of the load bearing capacity of the compacted material, its volume stability in response to soaking and drying, its component particle strength and durability.



Typical Pavement Design Catalogue (TRL Overseas Road Note 31)

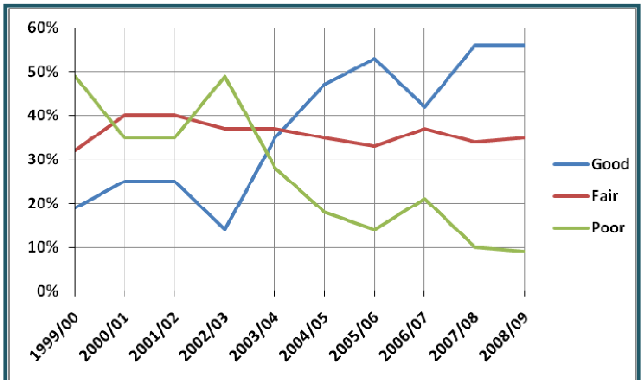
h) The following approaches are commonly used for LVR Pavement Design:

- Empirical Methods: direct correlation with existing roads within the same road environment.
- Catalogue Method: developed through research on a wide range of road environment situations and preparation of a matrix of solutions for varying traffic and subgrade strengths.

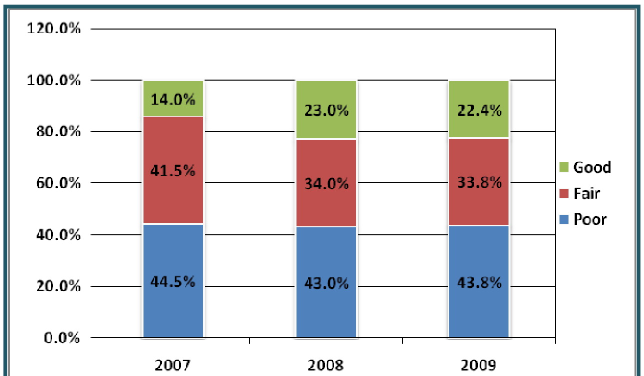
i) **Contract Specifications** are required to cover the complete the range of activities required to complete the satisfactory construction of a road. Specifications should cover site preparation, setting out and surveying, use of construction plant, use of construction materials, drainage and structures. The specifications should be clear and understandable, appropriate to the local road environment, capable of being applied by local contractors, and compatible with overall government regulation.

6. FINANCING RURAL ROADS

a) Financing of rural road maintenance has been strengthened through the establishment of **2nd Generation Road Funds** in a number of African countries. This was in response to the realisation that many governments don't prioritise funding for roads.



Condition of Trunk and Regional Roads in Tanzania since establishment of Road Fund



Condition of District Roads in Tanzania with allocations from Road Fund

b) The Road Funds have their own revenue sources based on the "**User Pays Principle**". Sources of revenue include levies on fuel sales, vehicle licensing and vehicle transit fees.

c) Successful Road Funds are founded on sound policies and strategies and backed by effective legislation. They have strong **Private Sector Participation** in the management of the Fund. In countries like Tanzania there have been considerable improvements to road maintenance as a result of effective sector reforms and establishment of the Road Fund.

d) Challenges faced by Road Funds include implementation constraints and cumbersome procurement rules. These constraints lead to unspent funds at end of financial year, but Road Funds have the advantage that they are able to roll over unspent funds to the following financial year.

7. THE ROLE OF PROFESSIONAL INSTITUTIONS IN RURAL ROAD PROVISION

a) Professional institutions can support the provision of rural access by promoting appropriate prioritisation of investments, the establishment of effective maintenance regimes, and the application of appropriate design standards.

b) Professional institutions can achieve this through:

- Dissemination and mainstreaming of best practice
- Promoting and formalising appropriate design standards

- Promoting ongoing research
- Continued Professional Development of members
- Training of practitioners.

8. ACKNOWLEDGEMENTS

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Joseph Haule	Manager Tanzania Road Fund