The Economic Benefits of Rural and Low Volume

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RURAL AND LOW-VOLUME SEALED ROADS (LVSR's)

CONTENT

FOREWORD

Everything that sustains us, whether grown, mined, or drilled begins on a low-volume road. Low-volume roads transcend language, culture, topography, and climate. Due to their basic necessity, they tend to drive innovation in design, material use, maintenance, and social development.

Nearly 30 million km of low-volume roads connect the world's population, yet, according to the World Bank, 31% of the world's population (1 billion people) still do not have adequate access to transport. Three-quarters of the population of the 21 least developed countries do not have access to all-weather roads, which are a key diagnostic measure of development. Accessibility, whether it is to markets, schools, health clinics, water points, places of worship, and community centers in rural areas or to the nearest town or city, is a precondition for the satisfaction of almost any economic or social need. Only 34 percent of rural Africans live within two kilometers of an all-season road, compared to 65 percent in other developing regions (Torero and Chowdhury, 2005). The World Bank and donor institutions have extensively championed rural roads as poverty alleviation instruments. Rural roads are key to raising living standards in poor rural areas. By reducing transport costs, roads are expected to generate market activity, affect input and output prices, and foster economic linkages that enhance agricultural production, alter land use, crop intensity and other production decisions, stimulate off-farm diversification and other income-earning opportunities, and encourage migration. Furthermore, by facilitating access to social service facilities, better roads enhance social outcomes.

CENTRAL ROLE OF RURAL ROADS IN POVERTY REDUCTION

In *Wasted Time: The Price of Poor Access*, Edmonds provides a graphic description of the link between isolation and poverty. He contends that "isolation and access are two sides of the same coin, with poor access as the defining characteristic of poverty. Lack of access has its impact at the most basic level of living;

> If there is poor access to health services or clean water, people will be and remain unhealthy. Any epidemic under such circumstances will be likely to have catastrophic results and children may die.
>
> if there is poor access to basic information, household living under these condition will be unaware of ideas, technology and necessary information which might otherwise assist them to raise their level of living;
>
> if there is poor access to education, children will inevitably face the same limitations confronting their parents today."

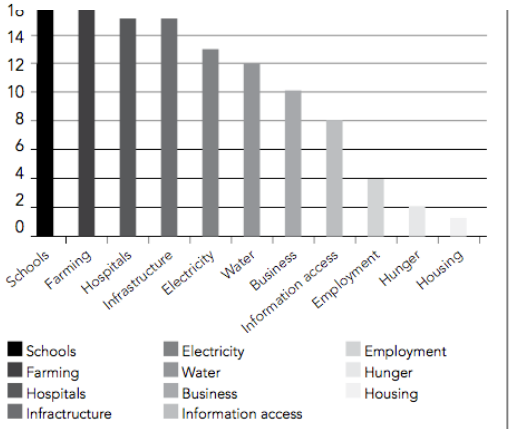
In his view, access is also related to poverty at a different level: "even if financial and physical access to the basic services is assured, this is actually only a starting point in the development process. If access to markets is difficult, farmers are hardly likely to diversify their production to include cash crops, or even to grow net surpluses of subsistence staples. Without such new ideas and opportunities poverty remains an endemic feature of rural life"

Whilst the case for improving rural infrastructure has been made by African governments in NEPAD's Comprehensive African Agricultural Development Programme (CAADP) and their development partners via other platforms, very limited progress has been made in actioning it. Progress in improving the Sub-Saharan Africa's rural infrastructure has also been limited largely as a result of the inability of its poorest countries to mobilize the necessary resources to successfully implement rural infrastructure projects. Furthermore, private investors have had little incentive to invest in infrastructure, whilst donors have shown little inclination to bridge the infrastructure financing gap. Investment in rural infrastructure is fundamental to unlocking the African Moment and has been well documented in theoretical and empirical studies. Growth in smallholder agriculture cannot be generated without augmenting productivity, which requires the building of effective infrastructure. Infrastructure needs for rural farming communities include amongst others, transport and communication services, energy, water and irrigational facilities and extension services.

Rural development, spurred by reforms introduced in the 1970s, has been the main reason for China's agricultural-led growth, particularly smallholder growth. As a result, poverty has been drastically reduced in China in the last three decades. Large scale construction of rural roads, coupled with an increase in agricultural research and development, and the implementation and provision of irrigation systems infrastructure, have combined to significantly impact on poverty reduction. Lessons drawn from the Chinese experience demonstrate that Africa too needs to introduce policies designed to incentivize smallholder farmers, supported by extensive investments in rural infrastructure, such as rural roads and irrigation to have a lasting impact on rural development. Similarly, investments in agricultural research should be increased and tailored to the continent's unique conditions from 2008 to 2010. African Monitor and its partners conducted Poverty hearings in which grassroots communities were invited to identify what they regarded as the most important issues for urgent government action. These hearings were held in South Africa, Kenya, Liberia, Senegal and Mozambique. Participants identified the lack of rural infrastructure as a major stumbling block to socio-economic improvement, and pointed out that it hampers each governments' poverty alleviation efforts. In the Kenya Poverty hearings for instance, it was found that national government efforts to assist the poor were generally failing due to the inadequate attention given to the informal sector and rural infrastructure. A strong and recurring message from the hearings was that government should improve rural infrastructure and access to markets.

Figure 1: Most important services to communities

1 Table 1: Most Important Service to Communities



Source: Mozambique Pre-Poverty Hearings Survey, 2010

CHALLENGES FACING RURAL ROAD CONSTRUCTION

The following extract is taken from the SADC Guideline to Low-volume Sealed Roads 2003 which was drafted by a team of international experts, namely;

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A new approach

*"The successful provision of a low-volume sealed road requires ingenuity**, imagination and innovation.** It entails "working with nature" and using locally available, non-standard materials and other resources in an optimal and environmentally sustainable manner.*

It will rely on planning, design, construction and maintenance techniques that maximize the involvement of local communities and contractors.

THE IN APPROPRIATENESS OF TRADITIONAL METHODS

Sub-Saharan Africa has approximately 700,000 kilometers of rural roads, with half of them in poor condition. Traditional approaches to the provision of low-volume sealed roads have stemmed from technology and research carried out in Europe and the USA over 40 years ago in very different environments. Locally prevailing circumstances are usually very different in terms of climate, traffic, materials and road users. It is therefore not surprising that many of the imported approaches, designs and technologies are inappropriate for application in the region.

Technology, research and knowledge about LVSRs have advanced significantly in the region and not only question much of the accepted wisdom on LVSR provision but also show quite clearly the need to revise conventional approaches. Unfortunately, there has been little effective dissemination and uptake of the results of research carried out in the SADC region. This has triggered the need for the *SADC Guideline on Low-volume Sealed Roads (available on request).*

WHY SEALED ROADS?

The substantial length of unsurfaced, particularly gravel, roads in the region is becoming increasingly difficult to sustain in that such roads:

- impose a logistical, technical and financial burden on most road agencies due to constraints on physical, human, financial and natural resources
- require the continuous use of a non-renewable resource (gravel) which is being seriously depleted in many countries and, in the process, is causing serious environmental problems

Extensive research has been undertaken in the SADC region over the past 20 - 30 years.

This has enabled local, "non-standard" materials to be successfully incorporated in appropriate pavement design for LVSRs.

Implementation of the results of regional research (for example, that reduce construction costs through the increased use of natural gravels), enable the sealing of gravel roads to be economically justified at less than 100 vehicles per day (vpd). This figure is in contrast to the previously recommended threshold values for Sub-Saharan Africa, which were in excess of 200 vpd and is a figure that still persists in the minds of many practitioners. Failure to observe the optimal timing for sealing gravel roads can be very costly to national economies, not only in terms of incurring excess transport costs but, also, in the continuing excessive maintenance burden and adverse socio-environmental effects. This provides a strong impetus for policy change and the adoption of alternative, cost-effective, surfacing strategies promoted in this Guideline.

AGGREGATE CONSUMPTION IN SOUTH AFRICA

South Africa – 30 million m^3 of gravel is lost on our roads per annum = 1 x Table Mountain every year. Imagine digging a hole the size of Table Mountain every year? Obviously, the indiscriminate use of aggregate is not sustainable.

THE BENEFITS OF USING THE SADC GUIDELINE TO LVSRs

There are a number of benefits to be derived from adopting the approaches advocated in the Guideline. These include providing LVSRs that:

- are less expensive in economic terms to build and to maintain through the adoption of more appropriate, locally-derived technology and design/ construction techniques that are better suited to local conditions
- minimize adverse environmental impacts, particularly as regards the use of non-renewable resources (gravel)
- increase employment opportunities through the use of more appropriate technology, including the use of labour-based methods, where feasible
- improve road safety in all aspects of road provision
- take better account of the needs of all stakeholders, particularly the local communities served by these roads
- foster local road building and maintenance capacity through the greater use of small-scale, local contractors
- ultimately, facilitate the longer-term goal of socio-economic growth, development and poverty alleviation in the region

In addition to the above, the Guideline will also generate awareness and disseminate the knowledge required if these benefits are to be enjoyed more widely in the region.

Research carried out in the SADC region by a number of international, regional and local organizations, which is conservatively estimated to have cost US $20 - 30 million, has questioned many of the accepted assumptions about the planning, design, construction and maintenance of low-volume sealed roads. This research has quite clearly shown:

- the importance of adopting a more holistic, sustainable approach to the provision of low-volume roads
- the need to revise conventional approaches to planning, economic appraisal and the environment
- the shortcomings of conventional specifications and, to some extent, of test methods, in assessing the adequacy of local materials for use in low-volume roads
- the advantages of adopting more appropriate geometric and pavement design standards
- the economic success of innovative construction methods
- the importance of paying greater attention to the environmental aspects of road provision

Promotion of labour-based methods where feasible, is a key factor in creating productive employment and reducing poverty.

The new idea either finds a champion or dies.....No ordinary involvement with a new idea provides the energy required to cope with the indifference and resistance that major technological change provokes ... Champions of new ideas must display persistence and courage of heroic quality.

SMART MATERIALS FROM MULTISEAL SYSTEMS

MultiSeal Systems –'' ‹‡ and develops environmentally friendly Smart Materials for road construction. These Smart Materials includes in-situ material binders, soil modifiers, asphalt modifiers and elastomeric mortar admixtures, which are ideal for LVSRs.

Smart Materials challenges the core of conventional road construction and design, by bringing in unprecedented resilient modulus flexibility, which is needed for Mechanistic-Empirical (ME) road design calculations. Smart Materials reduce the number of supporting aggregate layers for cement modified /stabilized flexible and rigid road designs and thereby substantially reducing construction costs.

SOILTECH Mk. III POLYMER STABILIZERS

SoilTech stabilizing polymers are elastomers and do not become brittle when cured. The elastomer is able to flex under load and unlike cement stabilization, will not crack under excessive loading. Another reason why sub-base and substrate layer works are virtually eliminated from the road design.

SoilTech MK III stabilizing polymer has been purposely designed to penetrate through the road's base layer, into the sub-base layer, via capillary action. This sub-base strengthening process is of significant importance as we are not only stabilizing the road's base layer, but also the sub-base. From a road design perspective, a strengthened sub-base may negate the need for further layer-works.

in many instances, transforms insitu materials that would normally be classified as unusable or waste materials, into suitably modified aggregates, for use in base and sub-base layer construction

With Smart Road Materials (SRM), one can;

- Reduce the consumption of quarry aggregate in conventional construction
- Speed up construction time
- Reduce construction costs
- dramatically reduce CO_2 emissions
- Reduced maintenance – as long as the asphalt wearing course layer is maintained, the structural integrity of the road will be preserved, with the road pavement remaining rut free and eliminating the need for base or sub-base maintenance.

These polymer advantages, addresses the pivotal factors influencing road construction costs. SoilTech stabilized roads, should be at least 30% more cost effective than conventional road designs.

Smart Road Materials are technological advancements in nano-polymer technology that drive innovation in new construction methodologies.

POLYMER ENDORSEMENTS

- **Prof. Alex Visser**

Professor – University of Pretoria, South Africa

Designs 10 Million Single Axle (ESAL) Road Design for India using SoilTech Mk. III polymer

- **Prof. S.K Rao**

Professor – Indian Institute of Technology, Kharagpur

"several stabilization compounds have come into existence. The new-technology stabilizers are polymer-based, some in liquid form and some in powder form. The polymer creates more stable compounds giving longer performance than conventional stabilizers like cement or lime."

SMART MATERIAL – LVSRs SOLUTIONS

The Resilient Modulus (MR) is a measure of subgrade material stiffness. A material's resilient modulus is actually an estimate of its modulus of elasticity (E). While the modulus of elasticity is stress divided by strain for a slowly applied load, resilient modulus is stress divided by strain for rapidly applied loads – like those experienced by typical roads.

This critical relationship of structural strength and high yield strain (elastic modulus), differentiates SoilTech polymer stabilization technology from conventional cement stabilization.

Structural strengths achieved with SoilTech polymer stabilization, exceed international single axle loading (80kN) standards by several hundred percent. A further major design benefit of SoilTech polymer, is the fact that although very impressive load bearing strengths are achieved, the elastomeric properties of SoilTech also provides unsurpassed tensile performance, for road stabilizing products. Engineers are now able to reduce the number of supporting layers, traditionally used to support conventional rigid or flexible pavement designs.

SMART MATERIAL ENABLERS

SoilTech Mk. III , a third generation polymer binder, is a stabilization agent specifically designed for base and sub-base stabilization. SoilTech has been extensively tested with [1]in-situ materials in various parts of the world.

WorleyParsons
resources & energy

EcoNomics

ANADARKO MOÇAMBIQUE ÁREA 1 LIMITADA
REPORT ON THE GEOTECHNICAL INVESTIGATION CONDUCTED FOR THE AMA1 RESETTLEMENT VILLAGE IN AFUNGI, NORTHERN MOZAMBIQUE

Table 10: Summary of Laboratory Tests Conducted on Polymer Stabilised Materials

Sample No.	Depth (mbgl)	Description	Particle Size (%)			Atterberg Limits		LS (%)	GM	% Polymer	Modified AASHTO Compaction		CBR Values (%)														Classification (Natural Sample)
			Clay + Silt	Sand	Gravel	LL	PI				MDD	OMC	Polymer Curing Time	Compaction MDD (%)						Polymer Curing Time	Compaction MDD (%)						
											(kg/m³)	%		90	93	95	97	98	100		90	93	95	97	98	100	
IPPBP1	0.50-3.50	Reddish brown sandy CLAY. Laterite	8	92	0	19	7	3.5	1.43	0.00	2094	8.7	N/A	47	56	63	74	81	97								A-2-4(0); SC-SM; Anticipate Low to Medium activity; G6; Type A - Erodible
										0.75	2092	9.0		47	56	62	76	85	107		65	77	86	104	115	142	
										1.00	2095	9.0	9 Days	43	49	55	76	89	122	15 Days	72	85	95	110	120	140	
										1.25	2093	8.7		41	54.0	65	84	97	129		67	84	98	117	128	153	

LL – Liquid Limit
PI – Plasticity Index
GM – Grading Modulus
MDD – Maximum Dry Density
MC – Moisture Content

Classification in Terms of: USPRA[6] USCS[7] TRH14[8]

TRH20[9] (1990)[9] Suitability for Gravel Wearing Course: A – Erodible materials B – Ravels and Corrugates C – Ravels D – Slippery when wet E – Good

Table 2. CBR test results from Worley Parson on sandy material in Pemba, Mozambique

[1] *Lab testing of all materials prior to road design is highly recommended, especially grading modulus and plasticity index.*

SMART MATERIAL ROAD DESIGNS

Typically, rural and low volume roads require a little more than a single layer (base layer) stabilization with SoilTech Mk. III polymer binder and a low-cost wearing course seal, to provide a cost effective and durable riding surface.

These simple designed roads, with minimal maintenance will service the community for 20 years plus. The oldest polymer stabilized road in Africa is in Johannesburg and is 17 years old and in very good condition.

Smart Materials were originaly manufactured for the stabilization of heavy mine haul roads. Subsequently, the products have been introduced into the formal road sectors with succesful projects completed in South Africa, Mozambique, Swaziland, Angola, DRC, India, Chile, Dubai and Bolivia.

CONSERVATIVE ADOPTION OF TECHNOLOGY

To Quote Albert Einstein "*We can't solve problems by using the same kind of thinking we used when we created them ".*

Similarly, we cannot continue to design and build roads in the same modus operandi that we have for the past 150 years. Conventional roads, based on Macadam layered-designs with a blacktop asphalt seal was introduced in the **1920'**s and is still used today!

RESISTANCE TO CHANGE

Cement monopolies own most of the stone quarries and have no interest in changing road designs. Large sponsorships to educational institutions, from these corporations ensure that very little attention is paid to alternative road design and construction methodologies.

There is no disputing the fact that highway specifications need to be of a very high standard, based on critical design elements. However, utilizing the Macadam layered approach in the design of rural or low-volume roads is simply a case of over-design, which is impractical, outdated and economically unfeasible.

Matola, Mozambique (2011)

150mm Stabilized with SoilTech Mk. III with a 10mm AsphalTech Seal

SMART MATERIAL CHARACTERISTICS

SoilTech Mk. III polymer binders in many instances display field CBR readings in excess of 200. It is a natural assumption that these readings would lead to brittleness in the pavement. However, this is not the case as the CBR of the pavement continues to increase as the polymer cures, the elastic modulus of the pavement increases, providing the necessary strength and flexibility required in the road to provided longevity and relatively low maintenance. The elastomeric properties of SoilTech polymers eliminate brittleness, rutting or pavement failure resulting from cracking.

SMART MATERIAL ROADS

2015 - 17 Years Old

Zeiss Road, Johannesburg (1998)

150^{mm} Polymer Stabilized 10^{mm} Chip & Spray Seal

Bita – Kingankati Road , DRC (2014)

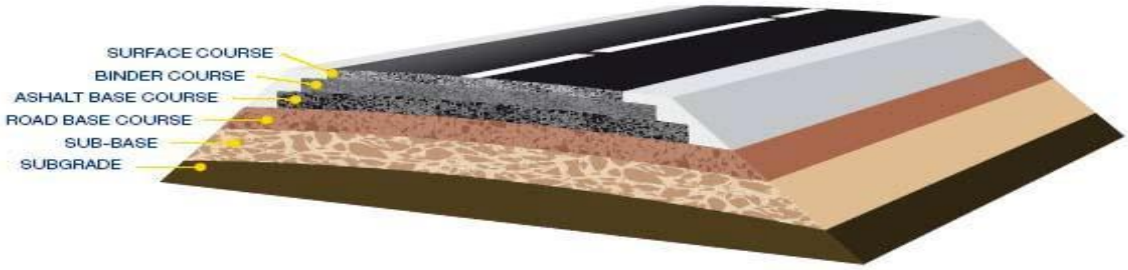
150^{mm} in-situ material stabilized with SoilTech & 30^{mm} AsphalTech Wearing Course

D9 Malkerns Road, Swaziland (2014)

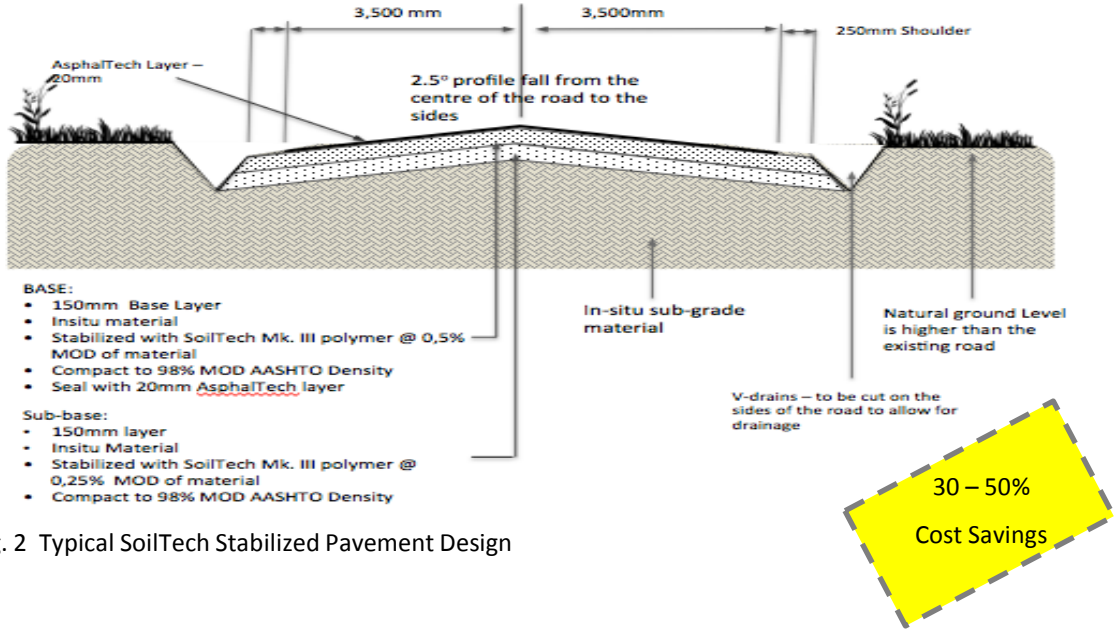
150^{mm} in-situ material stabilized with SoilTech &

30^{mm} AsphalTech Wearing Course

TYPICAL CONVENTIONAL MACADAM PAVEMENT DESIGN VS SOILTECH MK. III DESIGN



Diag. 1 Typical Conventional Macadam Pavement



Diag. 2 Typical SoilTech Stabilized Pavement Design

JOB CREATION & COMMUNITY EMPOWERMENT

Mobilize local communities into partnerships with for economic development and empowerment

Creating wealth among the poor cannot possibly be achieved without policies and programmes that specifically target rural empowerment

30 – 50% COST REDUCTION USING SOILTECH STABILIZATION

Utilizing insitu materials, results in the reduction of imported aggregates from borrow pits and thereby reducing material costs, construction time , as well as plant, labour and diesel costs. 30 – 50% More roads can be constructed with the same budget, not to mention quicker service delivery to the community.

JOB CREATION – LABOUR BASED BLACKTOP SEALS

MulstiSeal Systems have developed a range of blacktop, cold application seals for rural and low volume roads. These include;

5mm slurry seals

10mm slurry seals

20 -30mm slurry seals

Using imported aggregate or any non-plastic material, including beach sand. These seals can be applied, using conventional asphalt pavers, or the seal can be applied using manual labour, which is ideal for sustainable job creation.

MulstiSeal Systems have a seal that can be applied to any rural or low-volume road irrespective of the budgetary limitations.

Furthermore, SoilTech stabilized may be left unsealed for several ears, before applying a wearing course – without the need for extensive re-gravelling. This allows the municipality to budget for gravel road upgrading to blacktop with once again importing aggregate and redoing the gravel layer.

POTHOLE REPAIR

Pot-Tech is a water-soluble polymer based pothole and crack repair mixture for use on bituminous and asphalt road surfaces. The product can be mixed at a depot with in-situ soil aggregate and stockpiled for rapid distribution or mixed onsite. Pot-Tech can be premixed into 25 Kilograms plastic bags for ease of handling and transporting. There is a massive need for the maintenance and repair of potholes, cracks in the road and edge cracks. Traditionally tenders are awarded to large road construction companies for the maintenance of these roads. These funds could be better utilized by empowering dozens of small entrepreneurs who in turn would employ six or more persons per team.

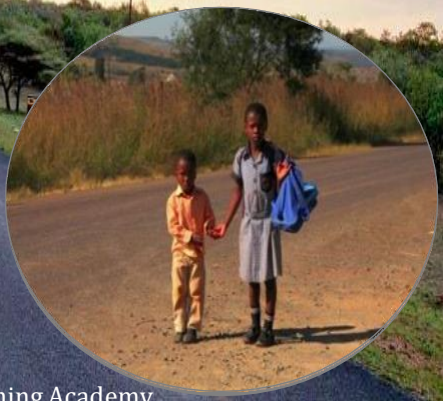
ROAD MAINTENANCE

Furthermore, the World Bank Technical Paper Number 14 on Sub-Saharan clearly shows that labour-based methods, with local funding and administrative resources for rural roads has proven difficult, as competition for resources is fierce. Experience has shown that successful rural road programs must include not only methodology and criteria, but also processes and procedures by all stakeholders

Smart Materials are cost effective, easy to apply and is certainly sustainable, even with a limited budget.

MULSTISEAL SYSTEMS – AFRICAN OFFICE

Johannesburg, South Africa



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