

# An Investigation on Remaining Service Life of Rural Roads

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**Abstract-** *The generalized Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and it results in the production of significant amounts of dust-like, high alkalinity bauxite residues known as red mud. Disposal of large quantities of red mud a solid waste generated at the Aluminium plants all over the world possess an increasing problem of storage, land cost and availability and pollution. Because of the complex physical-chemical properties of red mud it is very challenging task for the designers to find out the economical utilization and safe disposal of red mud.*

*Presence of soda in the red mud which when used in clinker production neutralizes the sulphur content in the pet coke that is used for burning clinker enrooted cement production and adds to the cement's setting characteristics. Based on economics as well as environmental related issues, enormous efforts have been directed worldwide towards red mud management issues i.e. of utilization, storage and disposal.*

*Different avenues of red mud utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. Experiments have been conducted under laboratory condition to assess the strength characteristics of the red mud. The project work focuses on the suitability of red mud obtained for construction. Five test groups were constituted with the replacement percentages 0%, 10%, 15%, 20% and 30% of cement by red mud in concrete. To achieve Pozzolanic property of red mud, hydrated lime was added. This paper points out another promising direction for the proper utilization of red mud.*

## I. INTRODUCTION

The term “rural roads” is often used imprecisely. Some countries use it to define all roads which are not national or secondary roads. Others lump together tertiary roads, which are part of the publicly owned network, with other local roads which are not included under the responsibility of the government. In this paper rural roads have been defined as all public owned roads whose primary purpose is to provide purpose is to provide direct access for rural village and

communities to economic and social services. Since the early 1980s massive investments have been made in rural roads. There were several reasons for this. In the first place it was a natural extension of investment into the lower parts of the road networks given the major investments that had been made in the national highways of most of the countries of the region. It was therefore a logical step to develop the whole of the road network.

The investments made in rural roads therefore seemed to be justified not only in purely transport planning terms but also in both economic and social returns that could be expected from these investments.

Firstly, the funds for road construction came from the capital development budget whilst funds for maintenance were expected to be sourced from government recurrent budgets. Often the investments for road building were financed by bilateral donors or from loans from the international development banks. Whilst the funding agencies often insisted that conditions were included in the agreements regarding the Governments' commitment to maintenance, limited efforts were made to enforce such commitments. If the maintenance dimension was raised in relation to these programs, it was commonly referred to as a government commitment without any further concerns to either funding or to the capacity to ensure that maintenance actually took place.

## Classification of Maintenance

Maintenance activities are commonly categorized in two distinct groups, depending on the location of the actual works. Off-carriageway works are mostly related to maintaining the drainage system, and halting any damages to the road components outside the road surface. This means that the side slopes, all drains and cross drainage structures are kept in a good condition that permits the free but controlled run-off of water away from the road. The second group of maintenance activities relate to road surface repairs. This work mainly consists of maintaining a good running surface on the road, free from any obstructions and damage and with the necessary cross-fall to secure proper drainage of the surface.

### Timing of Maintenance Inputs

Routine maintenance is a recurrent activity. Careful timing of work inputs forms an important part of an efficient maintenance programme. The prime objective when scheduling maintenance works is to ensure that the works are carried out as preventive measures, at an early stage when the road deterioration and damage are still limited. The works are therefore scheduled at strategic intervals when it is expected that the need for action is essential. For this reason, the timing of regular, or routine maintenance works are often related to the time of the year when rainfalls occur.

The most common work activities are:

- ✧ Erosion control on shoulders and slopes;
- ✧ Clear drains to allow free passage of water;
- ✧ Clear culverts and other waterways;
- ✧ Minor repairs to culverts and retaining structures;
- ✧ Repair and replace scour checks;
- ✧ Repair, fill and compact potholes and ruts;
- ✧ Grass and bush clearing;
- ✧ Repair road signs.

In addition to the routine maintenance carried out each year, the road will need a more extensive overhaul after a certain number of years. This periodic maintenance involves more comprehensive and costly activities such as reshaping of the road surface, re-surfacing and major repair or reconstruction of cross-drainage structures. Depending on the quality of the road, and the level of wear and tear, the periodic maintenance works would be scheduled at intervals of 3 to 7 years. Periodic maintenance includes activities such as:

- ✧ Major repairs to structures;
- ✧ Reshaping prior to resurfacing;
- ✧ Regraveling/resurfacing of entire road;
- ✧ Spot improvement/rehabilitation of failing sections;
- ✧ Installation of new culverts;
- ✧ Stockpiling gravel for use during routine maintenance.

### Maintenance Priorities

All road works agencies need to factor in budgetary limitations when planning their maintenance programme. Every engineer responsible for road maintenance faces the additional challenge that available funds are never sufficient. It is therefore necessary to assess the importance of the various work interventions to ensure that available resources are utilized in the most effective manner.

Among the three types of maintenance, obviously the emergency maintenance is the most important as it relates directly to keeping the roads open to traffic. In terms of non-emergency related works, experience clearly show that it is the regular or routine maintenance activities related to preserving the drainage system which have the most significant effect in terms of extending the lifetime of a road. These works do not involve any sophisticated technology or skills. They can be carried out using manual labour and simple hand tools and are inexpensive. Despite this, they still require a sound management organization to ensure that works are carried out at the right place and time.

### ➤ REVIEW OF LITERATURE

One of the most profound causes of the poor conditions of the roads in India is the overloading of the pavements by allowing movement of the overloaded vehicles with axle load in excess of the standard design axle load and by continuing the use of the deteriorated roads even after their service life. The axle load spectrum for the design of the pavements is derived from the existing traffic (surveyed) or assumed in case of a new road, and the cumulative standard axles (CSA) considered for the design will be used-up much quicker before the road attains the design life if the vehicles are overloaded, thus leading to faster deterioration of the pavements. Further, the roads which are designed and constructed or being constructed for a specific volume of vehicular traffic, should sustain greater traffic than anticipated, in the near future. Repair and rehabilitation of these roads shall be an on-going priority to increase their service life. The traditional methods of repair and rehabilitation incur high replacement costs and cause several days of traffic interruption, especially in heavy-traffic areas, such as major intersections, and on toll ways, where congestion/delay is most prevalent.

This situation particularly warrants in case of concrete roads. One of the most important components of fast-track construction of concrete roads is the design of suitable concrete mixtures. Fast-track concrete mixtures do not require the use of special materials or out-of the ordinary techniques but selection of materials including admixtures demands extra care. Review of literature on the failure causes of rigid pavements; properties and role of alternate cementitious materials and chemical admixtures in concrete; features of high early-strength concrete in fresh and hardened state at early and later age; alternate curing methods and durability aspects of concrete assume greater importance in the study on accelerated rehabilitation of rigid pavements.

## II. FAILURE OF RIGID PAVEMENTS

The defects apparent on rigid pavements may be due to deterioration of the concrete, restrained volume-change stresses, or overload evidenced by pumping and/or structural breaks.

prepared with a fixed amount of mixing water and with increasing amounts of red mud tend to set quickly due to the fineness of the waste material and its composition. The mechanical strength diminishes with increasing proportions of red mud in place of cement, but mortars prepared with a 50% substitution still show suitable strength for non-structural applications. The red mud recycling alternative proposed here appears to be technologically viable.

Collepari in his technical paper has mentioned that delayed ettringite formation (DEF) in the hardened concrete which occurs after months or years due to sulphate attack in rigid hardened concrete was responsible for cracking and spalling of concrete. The paper explained that the sulphate attack could be internal which occurs in a sulphate-free environment by the late sulphate ions release from either cement or gypsum-contaminated aggregate or could be external when environmental sulphate (from water or soil) penetrates into a concrete structure.

Lee et al. have investigated the premature deterioration of Iowa concrete highway in U.S.A. In the case of Iowa highway, the sulphate ions that promoted delayed ettringite formation were derived from the oxidization of Pyrite ( $\text{FeS}_2$ ) which was found in coarse aggregate of the concrete. The delayed ettringite formation was found to be the prime reason for the deterioration of the concrete. It was observed that in poorly performing concrete, ettringite completely filled many small voids, occurred as rims lining the margin of larger air entrainment voids and as microscopic disseminations in the paste. These findings are useful in selection of coarse aggregate, though this is always a matter of constraint in a particular area where pavement is to be constructed or rehabilitated.

Akoto and Niles have explained the various types of distresses and repair restoration techniques for rigid pavements. Depending on the condition of crack width, spalling and faulting condition, they have recommended repair and restoration techniques. Shallow spalling, shallow cracking, pop-outs and scaling were the reasons mentioned for partial depth repair and it was advised that partial depth repair should be limited to the top one-third of the pavement and should not bear on dowel bar. The distress identified for the full depth repair were blowup and corner crack of low

severity, D-cracking, joint deterioration (with faulting  $\geq 6$  mm), spalling (with faulting  $\geq 6$  mm) and transverse cracking all of moderate severity and longitudinal cracking of high severity (faulting  $\geq 12$  mm). They have concluded that Concrete Pavement Restoration (CPR) technique was cost effective compared with asphalt overlay and could save fuel consumption by as much as 20 per cent.

## III. SITUATION ANALYSIS

Rural roads are a fundamental element in the provision of access in the rural areas. However, such access has to be sustained otherwise the benefits will be lost. To be able to make meaningful suggestions regarding the provision of effective maintenance it is necessary to have an understanding of the current situation. This chapter looks at the physical, institutional and financial issues related to rural road maintenance in the region.

### The Road Network

Rural roads form part of an overall network and they are dependent on the higher order roads to serve their purpose and vice versa. In the first place it is useful therefore to see rural roads in the overall context of the road networks of the region.



Road Lengths by Country in Asia

	Kilometres of roads	Km per 1,000 population	Km per 100 Sq km	Percentage rural roads
China	1,809,828	1.4	18.9	76
Mongolia	49,250	17.6	3.0	77
Indonesia	368,263	1.5	19.2	79
Philippines	202,205	2.3	67.4	86
PNG	27,000	4.9	5.8	75
Cambodia	38,257	2.8	21.1	73
Lao PDR	31,210	5.0	13.2	70
Thailand	233,096	3.6	45.3	77
Vietnam	215,525	2.6	64.9	92
Afghanistan	23,700	0.8	3.6	75
Bangladesh	140,000	1.0	97.2	82
Bhutan	3,375	1.5	7.2	51
India	2,550,000	2.4	77.6	78
Nepal	27,000	1.0	19.1	83
Pakistan	280,000	1.7	34.8	52
Sri Lanka	108,000	5.4	163.6	60

Whilst there are some variations, shows that rural roads represent between 70 and 80% of the total length of public road networks. It should be recognized that they only account for some 15-20% of the traffic volumes on the network.

**Condition of rural roads**

	Percentage of villages having no road access	Percentage of rural roads in poor condition
India	50	60
Madhya Pradesh	62	80
Uttar Pradesh	50	80
Jharkhand		81
Himachal Pradesh	52	55
Philippines		65
Lao PDR	38	73
Bhutan	40% of the population have no road access	53% of district and 86% of feeder roads
Pakistan	34% of the population have no access to a road	>50
Indonesia	10% of the population have no road access	50
Sri Lanka		>70
Vietnam		35

**Road Maintenance**

**Institutional Arrangements**

Even before the decentralization process in the region, the administration and management of rural roads was often unclear and somewhat disorganized. If they were dealt with by the mainline road agency they were often treated as the poor relation of the road sector.

These two systems are replicated with some modifications throughout the region. The differences are related to the levels and lines of responsibility at the local level. In some cases the road agency still retains authority over the local agency dealing with rural roads, as in Laos. At the other end of the scale are the barangays in the Philippines who are the sole authority for the rural roads under their jurisdiction

**Institutional Arrangements in the Region**

	Institutional arrangements for roads	
	Main Roads	Rural Roads
Philippines	Department of Public Works and Highways	Provincial Government (provincial roads) Barangays (tertiary roads)
Indonesia	Ministry of Public Works (MPW), through its Directorate General of Highway	Ministry of Home Affairs Implementation devolved to local government
Cambodia	Ministry of Public Works and Transport	Ministry of Rural Development
Lao PDR	Ministry of Communications, Transport, Posts and Construction	
Thailand	Department of Highways	Ministry of the Interior Implementation devolved to local government
Vietnam	Vietnam Roads Authority and Ministry of Transport	Provincial and District Departments of Transport responsible to provincial authorities
Bangladesh	Roads and Highways Department (RHD) within the Ministry of Communications	Local Government Engineering Department (LGED), Ministry of Local Government, Rural Development, and Cooperatives
India (States)	State Ministry of Public Works	State Ministry of Rural Development and local government (village roads)
Pakistan	The National Highway Authority (NHA) under the Ministry of Communications	Provincial authorities, with implementation decentralized to the districts
Nepal	Ministry of Physical Planning and Works, Department of Roads	Department of Local Infrastructure Development and Agricultural Roads under the Ministry of Local Development Implementation devolved to district government authorities
Sri Lanka	The Ministry of Highways - The Road Development Authority	Ministry of Home Affairs, Provincial Councils and Local Government Implementation devolved to local government

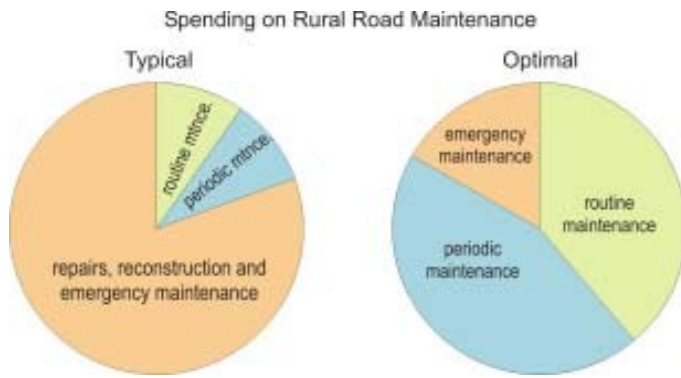
**Financing Maintenance**

Maintenance funding is a major problem in the road sector. There are several reasons for this. The result is that major parts of the road networks of the countries in the region receive little or no maintenance from one year to the next. The further down the network one goes, the lower the amount of funds that are available

**Levels of funding**

Figures for overall fund allocation and expenditure on road maintenance are notoriously difficult to come by. Maintenance is often not classified as a separate item in the budget or it is listed under the capital investment budget rather than the recurrent budget; budgets for maintenance are often used for improvement; funds may be earmarked for projects which in fact are periodic do not maintenance activities; different agencies are responsible for different classes of roads; often recurrent budgets differentiate between road maintenance and other recurrent activities. Allocations, particularly at the local level, are more difficult to identify. Road maintenance allocations, being part of the recurrent budget, are easily commandeered for other more pressing activities.

**Lengths of the rural roads in different countries**



Country	Length of rural roads km
Cambodia	27,800
China	1,371,235
Indonesia	291,841
Lao PDR	21,710
Mongolia	37,923
Philippines	164,719
PNG	15,000
Thailand	179,484
Vietnam	130,000
Afghanistan	17,775
Bangladesh	205,101
Bhutan	1,721
India	1,985,000
Nepal	22,410
Pakistan	145,600
Sri Lanka	64,700
Total	4,682,019

**Source of Funds**

Maintenance, by definition, is a recurrent activity and should therefore be funded from the recurrent budget. This would help to ensure that its role as a preventative rather than a curative measure was appreciated. For rural roads, which are often under the responsibility of decentralized authorities, funds for maintenance are rarely allocated as part of the recurrent budget. Rather funds are provided from the capital budget according to perceived need, in particular in relation to ensuring that certain roads remain passable. There seems to be little acceptance that constant care of a road would result in prolonging the time when a major input of funds is required to solve the problem caused by the lack of recurrent maintenance.

**Budgeting maintenance as repair projects**

In several countries in the region, the description of road maintenance in the budget reflects the curative rather than preventive approach to maintenance. Funds for maintenance are instead allocated to “small”, “medium” and “big” repair works. There is therefore a major effort required not only to develop an effective and realistic rural road maintenance system but also to create a planned maintenance culture.

**cost and Actual Expenditure for the Road Network**

Country	GNP per capita	Cost of full maintenance as a percentage of GNP	Maintenance expenditure as a percentage of GNP
Cambodia	300	2.1	0.19
Lao PDR	340	3.7	0.17
Vietnam	480	1.1	0.22
Mongolia	480	9.1	0.08
Bhutan	630	1.6	0.38
Indonesia	810	0.5	0.03
Philippines	1080	0.5	0.16
China	1100	0.3	0.1
Thailand	2190	0.4	0.19

Because funds are allocated for projects, the money tends to be spent on rehabilitation of unmaintainable links. Because the funds are not spent in general on the continuous maintenance of maintainable links these links become unmaintainable. In addition, the rate of deterioration of the maintainable network is faster than the improvements brought about by rehabilitation. Consequently the overall maintainable network becomes smaller.

**Finding the Funding**

The solution to this problem from an economic point of view is to treat roads as a commercial proposition. Roads serve transporters and the users should therefore pay for this service in relation to the use they make of the service. This is the basis of the Road Funds which have been set up in several countries of the region - India, Laos, Mongolia, Nepal, Pakistan, Philippines, PNG and Sri Lanka

**LACK OF MAINTENANCE**

**ECONOMIC AND SOCIAL IMPACTS**

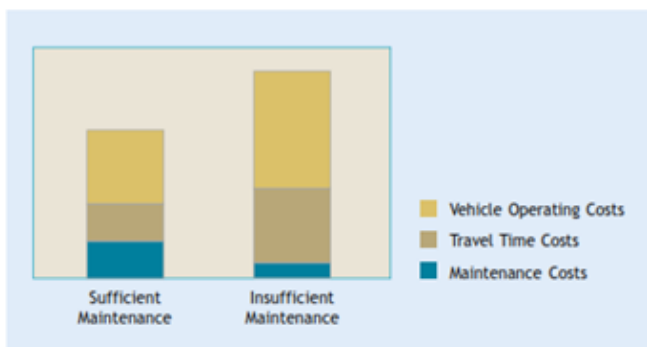
**Overall Implications from Lack of Road Maintenance:**

The social and economic impacts of rural roads are well established. Communities and local governments often attach a high priority to rural road improvements. Rural roads improve rural access, which facilitates marketing, schooling

and health services. Better access provides the opportunity for increased income and employment opportunities and can also contribute to the alleviation of poverty. Still, maintenance of rural roads is seriously neglected in many countries. This chapter focuses on the economic and social implications of such neglect.

Maintenance costs are generally small compared to other direct costs of road travel. The impact of maintenance on vehicle operating cost and travel time cost can be considerable. Figure 4.1 illustrates the effect on direct transport costs (VOC and travel time) of neglecting maintenance. In addition, with insufficient maintenance, the road will deteriorate and the operation costs for the road will also increase. It needs to be noted that this example does not consider the costs of any negative socio-economic impacts due to a lack of maintenance and a possible negative impact on accidents.

### Effects of Neglecting Maintenance



shows the different types of costs for rural roads

- ✧ owners of private vehicles (increased vehicle operation costs and faster depreciation of cars, motorcycles, bicycles)<sup>19</sup>
- ✧ owners and operators of transport services (increased vehicle operating costs)<sup>20</sup>
- ✧ passengers (increased travel times, higher fares, lower frequency, less comfort)
- ✧ farmers, entrepreneurs and traders (higher transport costs of inputs and raw materials and higher prices of hauling produce to the market)
- ✧ government agencies in their efforts to reach local communities providing outreach services such as health, education and agricultural extension services
- ✧ communities' ability to maintain social contacts.
- ✧ children travelling to school

✧ local people in their efforts to reach locations for employment or partaking in economic activities located outside their communities



### The Direct Implications

If not maintained, rural roads rapidly become impassable to motorized traffic until a point that they are no longer trafficable. The pace of deterioration largely depends on the quality of initial construction, surface materials, drainage measures, levels of traffic and weather conditions.



### Depreciation of the Value of the Road Network

For many countries in Asia roads are their largest assets.<sup>21</sup> The replacement costs, in case these assets are lost, amount to a significant percentage of GDP. Rural roads constitute a major part of the assets in a public road network. Overall for 15 countries in the region, the asset value of rural roads alone represents 27% of the overall GNP.

According to a 1988 World Bank study, <sup>22</sup> allocations for road maintenance over a twenty year period had been so low that nearly 15% of the capital invested in main roads - roughly US\$43 billion equivalent to 2 percent of these countries GNP - had eroded due to lack of maintenance. The same study demonstrated that reconstructing these roads - costing US\$40 to US\$45 billion worldwide could have been

avoided by spending US\$12 billion on maintenance. This is a ratio of about 3.5 to 1, not taking into consideration the time value of money.



**Asset Management**

Local authorities often underestimate the importance of road maintenance and consequently budgets for maintenance are usually severely constrained. Introducing an asset management approach to local decision-makers may generate more political and local support for road maintenance activities.

- ✧ Local agencies should aim at increasing the total value of the network (and thereby maximizing access). Available investment funds should therefore be efficiently balanced between the demand for maintenance on the one hand and construction of new roads (and the rehabilitation of roads in total disrepair) on the other;
- ✧ Local decision makers themselves should be involved in assessing the results of different allocations in terms of value (and quality) of the total road network.

Assumption	Effect
Assume that a Local Government Unit (LGU) owns 200 km of roads in maintainable condition. Total construction cost per km is estimated at Peso 1 million per km.	Asset value of the maintainable road network is 200 million Peso
Assume the annual maintenance cost is 50,000 Peso per km per year (5% of the construction cost). If this amount was spent on maintenance, the network would remain in good condition (and the asset value would remain the same)	Total maintenance requirements are 10 million Peso. The LGU will have to spend 10 million Peso annually to keep the existing road network in good condition
Assume that a road deteriorates to an impassable condition in 5 years time if no maintenance takes place and that the cost of rehabilitation is 60% of the new construction cost or Peso 600,000 per km	If no maintenance takes place, the road value is reduced by 120,000 Peso every year.
Assume that the LGU has an annual budget for road works (maintenance and new construction) of 20 million Peso.	
Assume that the LGU gives first priority to all maintenance works and use the remaining funds for new construction	The value of the road network will be 245.2 million Peso at the end of year 5 (beginning of year 6)
Assume that the LGU spends all funds on new construction and no maintenance takes place	The value of the road network will be 184.3 million Peso at the end of year 5

**Increasing Transport Costs**

With improved roads, transport cost savings occur both through lower costs of existing traffic and lower costs of generated and attracted traffic. The assumption is that traffic will grow as a result of road improvements. A deterioration of the road network on the other hand will gradually reduce traffic levels. Moreover the unit transport cost will increase.

- ✧ traffic levels go down while transport costs and transport time increase,
- ✧ there will be a negative impact on (agricultural) production,
- ✧ average annual household income will decrease.

**Declining Rural Access**

Rural roads are important to provide the opportunity to realise the productive potentials of agricultural land, facilitate schooling, health services and marketing and satisfy other social and economic needs. If rural roads are not maintained properly, access will deteriorate and these activities will be negatively affected.

**Increase in Rural Traffic**

The impact of improved road access in rural areas is clearly demonstrated when a new road is constructed or an old road is rehabilitated. A common scenario in many developing countries is that rural communities do not have any road access at all or at best the village is connected with a track which is open for 4x4 vehicles only during the dry season. As a result of this direct access situation, any transport of goods and people is essentially by foot or at best with the occasional animal drawn cart.

**Maintenance and Poverty**

Access is accepted as being of prime importance to the achievement of the MDGs. There is also good justifiable evidence that rural roads provide much of the access needs of the rural population. However it is not the construction of roads that ensure the access. If they become impassable after the first rains then their access value is lost. It is maintenance which provides the sustained access and contributes to the achievement of the MGDs.

Whilst rural roads are not mentioned specifically in the MDGs, it is clear that they contribute directly through the provision of access. Of the eight MDGs, 31 viz,

- Goal 1. Eradicate extreme poverty and hunger
- Goal 2. Achieve universal primary education
- Goal 3. Promote gender equality and empower women
- Goal 4. Reduce child mortality

**Rides and frequency**

Respondents report to have doubled their rides as compared to before the road was built. This counts for half of all motorcycle drivers, most of the motor trailers, ox-carts, bicycles and pedestrians.

### Prices of goods

In general prices of basic goods drop. More vendors increase competition. Vendors report that the rehabilitated roads contribute to better and larger supply of goods, which cuts costs and forces prices down.

## IV. DECENTRALISATION

Rural road maintenance is a local activity, affecting local people. It is therefore reasonable to expect that the decentralization of the responsibility for implementing maintenance of rural roads would be beneficial to all concerned. There is a better understanding of the condition of the network at local level both by the local population and those responsible for its upkeep. There is the chance that local people could be involved in the monitoring of overall performance and the delivery of maintenance. The importance of maintaining local roads are important to local communities and if funds are available to local bodies, the maintenance can be made more responsive to the actual requirements of the local road network.

It is not the intention in this chapter to discuss in detail the general advantages and disadvantages of decentralization. The issue here is in what way does, or can, decentralization affect rural road maintenance



### Attitude and Perception

Maintenance has always been the poor relation of the road sector. It is viewed as important only by its absence, when roads deteriorate to the point that they are no longer serving their intended purpose. It is seen this way because it is not perceived as being in the interest of any of the stakeholders involved. The fact that those responsible are closer to the users in a decentralized system does not necessarily mean that sustaining the road network will be taken any more seriously than under a centralized system.

### Finance

In their comprehensive review of experience of decentralization of road administration, 33 Robinson and Stiedl suggest that “it appears that most attempts to decentralize responsibility for rural transport infrastructure have done little to address the funding problem”. There appears to be several reasons for this in relation to maintenance.

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Nevertheless it is clear that certain basic measures could be applied at the decentralized level to ensure that

- ❖ At least a basic minimum of funds are allocated to maintenance and
- ❖ That there is sufficient local technical capacity to spend it more effectively.

## V. INSTITUTIONS

The most important institutional issue is that of capacity. This has been poorly dealt with in the devolution process. Even if sufficient funds are available, if there is no capacity at the local level then the efficiency gains referred to above will not materialize. In the roads sector relatively little has been put in place during the decentralization process to ensure that local authorities possess the knowledge and skills to effectively deal with road maintenance.

- ❖ Technical staff
- ❖ A thorough knowledge of road network
- ❖ Sound procedures for road condition inventories
- ❖ Efficient planning procedures
- ❖ Effective procurement systems
- ❖ Good supervision
- ❖ Adequate logistical support
- ❖ Transparent and up-to-date reporting
- ❖ Reliable financial management

## VI. CONCLUSION

1. Rural Roads form a major part of the total road network of a country. According to UN-ESCAP definitions on average 71 % of the total road length are rural roads.



2. The definition of rural roads differs. The Asian ESCAP-study defines the connection from villages to markets or to the nearest road of a higher category as rural roads, but also those which directly serve farms.
  3. The funding for Rural Roads follows quite different patterns: Sometimes no effort is made to mobilize funds for rural road maintenance, sometimes voluntary organizations are involved in funding. In some cases the agricultural sector pays for it through an agricultural levy.
  4. Emerging countries like Thailand or the Philippines allocate funds from Central Government on a per kilometer bases, decentralize the execution of works or allocate 20% to 25% of the national annual road maintenance budget for the Rural Roads.
  5. It should be noted that, generally, no effort is made to handle rural roads individually or to establish cost-benefit analyses for them. The funding approach is a global one, sometimes more or less parallel to the political decisions on other rural infrastructures such as clean water or rural electrification.
  6. (Therefore funding and - eventually - the cross-subsidization procedures of other rural infrastructure measures may display possible solutions for the necessitated constant flow of funds).
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Maintenance of rural roads has been highly neglected over the years in India. However, with the huge programmes that have been undertaken in the recent years through PMGSY and Bharat Nirmanprogramme, it is but natural that maintenance of these assets be taken seriously, otherwise the country will lose huge amount of money in the end.

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