

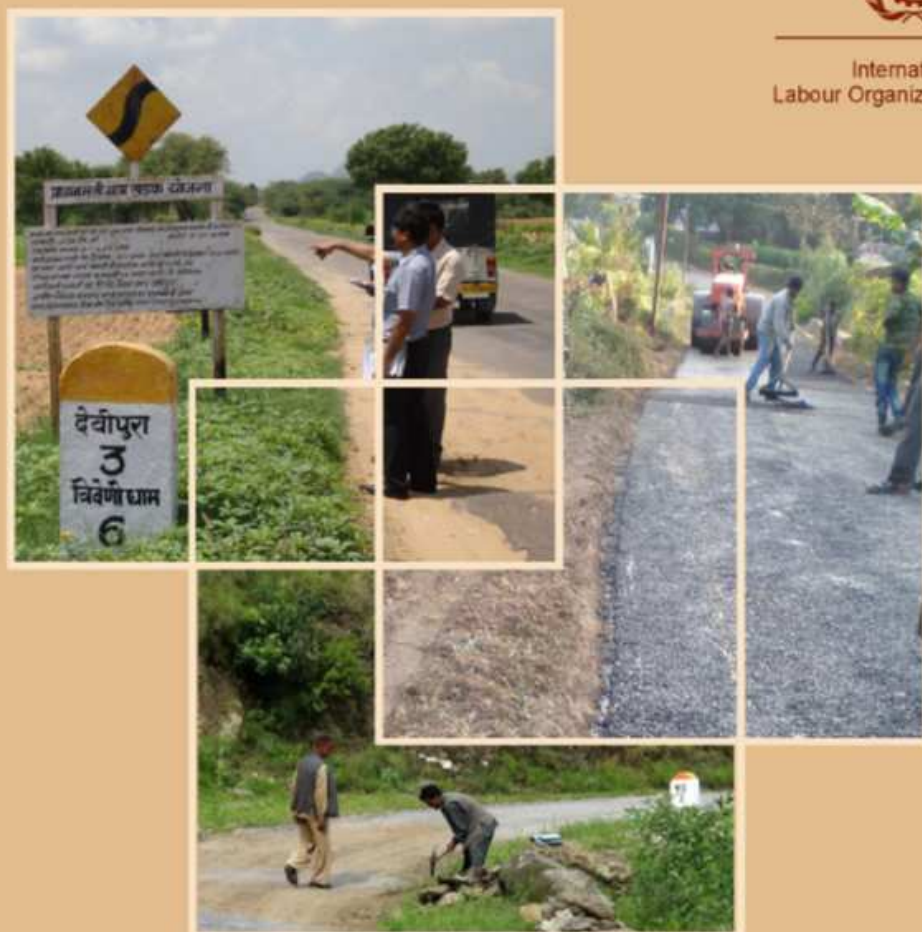
# Managing Maintenance of Rural Roads in India



NRRDA



International  
Labour Organization



New Delhi, October 2014



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**NRRDA**

National Rural Roads Development Agency  
Ministry of Rural Development  
Government of India



# Table of Contents

<b>Abbreviations</b>	<b>iii</b>
<b>Acknowledgements</b>	<b>1</b>
<b>Introduction</b>	<b>3</b>
<b>1 Rationale for rural road maintenance</b>	<b>7</b>
1.1 Purpose of maintenance	7
1.2 Types of maintenance	10
1.3 Benefits of maintenance	12
1.4 Deteriorating rural access	15
1.5 Attitude and perception	18
<b>2 Current Setting</b>	<b>21</b>
2.1 The rural road network	21
2.2 The maintenance challenge	24
<b>3 Financing rural road maintenance</b>	<b>31</b>
3.1 The challenge	31
3.2 Funding confidence	33
3.3 Funding sources	35
3.4 Preparing a financing plan	42
3.5 Managing road maintenance funds	46
3.6 Funding priorities	48
3.7 A preventive approach	51
3.8 Asset management	52
3.9 Economic analysis	56
3.10 Routine maintenance priority	57
3.11 Cost of maintenance works	58
<b>4 Technical considerations</b>	<b>65</b>
4.1 General	65
4.2 Functional requirements or rural roads	66
4.3 Design standards	70
4.4 Drainage	73
4.5 Pavements	85

4.6	Timing of works	92
4.7	Classifying the condition of the road	92
4.8	Technology choice	98
<b>5</b>	<b>Institutional arrangements</b>	<b>101</b>
5.1	Organization	101
5.2	Maintenance arrangements	104
5.3	Capacity of technical agency	108
5.4	Structure	109
5.5	Training	114
<b>6</b>	<b>Planning and implementation</b>	<b>119</b>
6.1	General framework	119
6.2	Planning maintenance	122
6.3	Road inventories	124
6.4	Maps and graphical presentations	127
6.5	Road condition surveys	128
6.6	Assessment of maintenance requirements	135
6.7	Prioritising and scheduling maintenance works	138
6.8	Service levels	143
6.9	Estimating and budgeting	145
6.10	Work preparations	147
6.11	Work programme	149
6.12	Safety at the work site	152
6.13	Reporting	153
<b>7</b>	<b>Contracts management</b>	<b>159</b>
7.1	General	159
7.2	Private sector involvement	160
7.3	Packaging of works	163
7.4	Common forms of contracts	168
7.5	Preparing contracts	173
7.6	Contracts management	174
7.7	Work supervision	177
7.8	Defects liability period	178
7.9	Performance contracting	179
	<b>Appendix 1 Reference literature</b>	<b>185</b>

## Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
BoQ	Bill of Quantities
CBO	Community Based Organization
DBST	Double Bitumen Surface Treatment
EIIP	Employment Intensive Investment Programme
IAP	Integrated Action Plan
ILO	International Labour Organization
IRC	Indian Roads Congress
IRR	Internal Rate of Return
km	kilometre
km/h	kilometres per hour
PCI	Pavement Condition Index
PMGSY	Pradhan Mantri Gram Sadak Yojna (Prime Minister's Rural Road Programme)
PPP	Public-Private Partnerships
PRI	Panchayati Raj Institutions
MDG	Millennium Development Goal
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MoRD	Ministry of Rural Development
MoRT&H	Ministry of Road Transport and Highways
NPV	Net Present Value
NRRDA	National Rural Roads Development Agency
RES	Rural Engineering Services
RMMS	Road Maintenance Management System
Rs	Rupees
TA	Technical Agency
TMP	Transport Master Plan
ToR	Terms of Reference
WB	World Bank
WBM	Water-bound Macadam
wd	workdays





## Acknowledgements

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This document has been prepared as part of the technical assistance provided by the International Labour Organization to the Prime Minister's Rural Road Programme (PMGSY). This technical collaboration with the National Rural Roads Development Agency is funded through the financing provided by the World Bank to the Rural Roads Project.

Road construction work is well documented in India through an extensive library of technical guidelines, manuals and specifications. As such, the quality standards of road works are well detailed and resulting in high quality outputs reflecting the functional objectives of such guidelines. Road maintenance forms part of the works carried out to provide adequate transport infrastructure. From a technical point of view, there is no shortage of technical guidance on how the works should be carried out. The challenge seems to be more related to how maintenance should be organised and when it should be carried out.

The technical aspects of road maintenance are addressed in several good publications guiding the provision of a functional rural road network in India. A number of these documents are referred to in this Guide. The intention of this document is however not in any way to replace any of the literature currently available on this topic but rather to complement it by presenting a series of good practices and management arrangements that have proven effective in terms of providing timely maintenance to rural roads.

Observations regarding rural road maintenance practices in this document are based on findings from an extensive situation analysis carried out by the ILO in the states participating in the Rural Roads Project as well as earlier studies carried out in India and elsewhere. As such, it includes lessons learnt and best practices from within the country and elsewhere.

Maintenance practices vary in different parts of the country. Equally, the environment and traffic patterns show a high level of diversity depending on the location. Finally, it is recognised that the organization of the road sector and its technical and managerial resources vary from one state to the other. It is therefore important to acknowledge that there is no standard solution to be applied in terms of reaching optimal arrangements. Still, there are key issues which apply everywhere and which need proper attention in order to secure adequate and timely maintenance of the rural road network.

It should also be acknowledged that some states have managed to establish a fairly well functioning maintenance system for its rural road network, while others are still in early development stages. In some places, the systems are well established, however, due to resource constraints their coverage is incomplete. For this reason, only parts of this Guide may be of relevance to some readers, as some of the issues are already addressed in some of the states.

As such, it is important to point out that the Guide has been prepared with the knowledge that elaborate road maintenance management systems have already been introduced in several states. This document makes no intention to replace those systems but rather attempts to place further attention to the importance of such management arrangements.

This Guide has been prepared with inputs from the technical assistance team of the ILO in close consultation with technical staff from the various road agencies in the participating states of the Rural Roads Project.

## Introduction

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A wide range of government institutions are building rural roads in India. The Village Roads (VRs) and Other District Roads (ODRs), two categories of roads referred as Rural Roads, are normally under the jurisdiction of the Public Works Departments or Rural Development Departments within the State government administrations. There are also various agricultural marketing boards and similar agencies mandated to build and maintain rural roads. In addition, the Panchayati Raj Institutions at local government levels are in charge of some portions of the rural road network.

Since December 2000, the Government of India has through the PMGSY embarked on a massive programme to provide connectivity to habitations through the rural road network across the country. The programme aimed to connect all habitations with a population of more than 500 inhabitants with all-weather roads in plains and 250 in hill states, desert areas and tribal areas. Rural road connectivity remains a highly important priority and as a result similar programmes are on-going in many states to connect smaller communities.

The year 2013 saw the launch of PMGSY-II with the objective to consolidate the existing rural road network and upgradation of existing rural roads particularly that provide connectivity to rural growth centres and other critical rural business hubs. Maintenance of these roads is to be planned as area based maintenance contracts.

Considering the impressive results of these programmes, it is clear that this targeted focus on improving the quality of rural access has been extremely successful. The reasons for its success can to a large extent be credited to the effective management put in place to implement this programme, including key components such as establishing capable client organizations, streamlined procurement procedures, standardised technical designs, sound monitoring and quality assurance procedures and a regular and adequate flow of funds from central authorities down to project implementation levels. As such, there are a string of lessons

learnt and practices serving as good examples on how to organise large-scale infrastructure programmes.

As a result of the PMGSY and other programmes the rural road network has experienced a considerable growth in terms of its total length. Also, these programmes have contributed to a significant improvement of the quality of the rural road network. Tracks and trails and other local roads in a very poor shape have been upgraded to all-weather standards with proper pavements, drainage and river crossings.

This massive improvement of the rural road network has several benefits, both in economic and social terms. Communities are no longer isolated and can partake in mainstream economic and social activities and access to basic services such as health and education is improved as a result of the improved roads.

The continued extension and improvement of the rural road network does however create new and growing challenges in terms of an increasing maintenance burden. In order to sustain the benefits of the investments made in improving village roads, there is a need to boost capacity in terms of providing adequate maintenance. After all, the expected benefits in terms of social and economic development will only materialise if the good transport infrastructure is maintained over time.

When road networks mature as a result of reaching the desired coverage of the rural population, more emphasis needs to be placed on the maintenance of already existing infrastructure assets. This implies that a growing portion of funding and technical and managerial capacity need to be allocated to protecting the investments made earlier in building the road network.

In order to sustain the quality of the all-weather roads built to service rural areas, there is a need to mobilise political support for this change process to take place. Secondly, it involves significant changes within government institutions in charge of the road networks. A growing portion of total funding needs to be allocated to maintenance of existing roads together with the technical staff required to attend to road maintenance.

This process is already on-going, although at various levels of progress. In some states, these new challenges are to a large extent recognised and adequate measures are being put in place to address the increasing maintenance challenge, while in other parts of the country, the emphasis still remains on construction works with too little attention given to maintenance of existing assets.

There is a need for a clear policy formulation to guide decision makers on how this change process needs to take place. Road policies should include key functional requirements that secures the quality of the existing rural road network from deteriorating, while new connectivity and up-gradation works continue. Equally, there is a need to define requirements at operational level, ensuring that financial as well as appropriate management arrangements are secured in order to actually carry out the necessary maintenance. This Guide attempts to describe the functional requirements at operational level necessary for securing adequate maintenance of the rural road network.



# 1 Rationale for rural road maintenance

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## 1.1 Purpose of maintenance

The basic objective of road maintenance is implicit in the word itself. It is done to ensure that the road that has been constructed, or improved, is to the extent possible kept in its original condition. All roads require maintenance as they are subjected to traffic and the forces of weather. Even with the highest possible quality of construction, maintenance is essential to get optimum service from the road structure during its design life. By applying preventive maintenance, the deterioration of the road and its components can be slowed down, thus postponing the need for costly investments in rehabilitation and securing the planned design life.

If not maintained, roads rapidly become impassable to motorised traffic until a point when they are no longer trafficable. The pace of

deterioration largely depends on the quality of initial construction, pavement and surface materials, drainage measures, levels of traffic and weather conditions. Gravel roads deteriorate more quickly than bitumen surfaced roads and their value can often be assumed to be negligible after five years without maintenance. Bitumen surfaces may have a marginally longer life without maintenance but are more expensive to rebuild. It should also be noted that for rural roads where traffic is more limited, the critical maintenance interventions are often related to maintaining the drainage system. Contrary to common perceptions, the maintenance priorities on rural roads are often related to off-carriageway (and cross-road) structures and not so much to road surfaces.

### Definition

The Indian Roads Congress defines road maintenance as “routine work performed to upkeep pavement, shoulders and other facilities provided for road users, as nearly as possible in their constructed conditions under normal conditions of traffic and forces of nature”. Maintenance is “essential to get optimum service from the pavement structure during its life period.”

Maintenance ensures that the road remains serviceable throughout its design life. Maintenance is important because it:

- ✓ reduces the rate of deterioration, thereby safeguarding previous investments in construction and rehabilitation,
- ✓ lowers the cost of operating vehicles on the road by providing a smooth running surface,
- ✓ improves safety of road users,
- ✓ improves the reliability of the road allowing it to remain open for traffic on a continuous basis and thus contributes to more reliable transport services, and
- ✓ sustains social and economic benefits of improved road access.

The first purpose is primarily in the interest of the responsible government authorities. Road agencies need to protect their investments made in improving the road network, thereby maintaining high service levels for the road users. The last four are of interest to vehicle operators and the inhabitants of the area serviced by the road.

### Road safety

Road maintenance also has an impact on the safety of road users. Regular maintenance heightens the reliability for road users through the simple fact that damages are dealt with at a stage before they become a hazard. Timely maintenance also includes the upkeep of signage and road markings which contribute to road safety. Keeping road shoulders clean and free from potholes allows pedestrians and cyclists to travel safely at a distance from vehicles. Clearing bushes improves sightlines and allows road users to spot each other in time. Finally, when roads are more closely monitored through regular inspections and by staff providing on-going maintenance, damages such as debris and rock-fall, collapsed culverts, landslides, washouts, etc., posing serious traffic hazards, can be detected in time and the required remedial measures can be provided in a timely fashion.

No matter what technical designs are chosen, all roads, from major highways to local roads, require regular and timely maintenance in order to secure a reasonable lifetime on the construction investment. Attempts to find technical designs that are maintenance-free are disillusioning and in



the long run only prove that lack of maintenance leads to accelerating rates of deterioration.

### Breaking a vicious circle

Without an organised approach to preserving the road network, it is often seen that road works agencies are forced into a situation of consistently dealing with the effects of the lack of maintenance, having to repair and reconstruct road sections that have failed since timely and adequate maintenance interventions were not carried out.

For obvious reasons, the first priority is to keep all roads open throughout the year (accepting that some road sections are not passable during extreme weather conditions). Without a preventive maintenance system in place, the efforts to keep roads open very much consists of carrying out repairs after serious damage has taken place. Such interventions are much more costly than preventive maintenance. Due to the extent of damages each year, the remedial works often consume the entire road works budgets, leaving little resources for preventive measures.

With the damages taking place during the next rainy season, road agencies are left with no alternative than to use subsequent budgets to once again repair serious damages to its roads. Although these repairs are necessary, it is obvious that this way of managing the road network is costly and ineffective. The only way of breaking this vicious circle is to introduce the concept of preventive maintenance, thus reducing the extent to which the roads require major repair works. The cost savings in repair works can then be brought forward to the next maintenance season and instead utilised for further preventive activities that may preserve the road assets.

It is important to make a clear distinction between maintenance and repair works. Effective maintenance is clearly time linked and is carried out before major damages take place. This involves activities relating to supervision and monitoring of the road assets even while they are still in good condition. It also requires that road authorities are sufficiently responsive and capable of taking action when required - as opposed to responding with repairs when major damages have taken place or road access has finally been cut off.

Timely and regular maintenance requires securing sufficient funding before repairs and maintenance become an urgent matter. The most effective maintenance is achieved when an organization is capable and prepared to carry out appropriate interventions at an early stage of

deterioration and thus limit the extent of damages. This implies that the responsible authority is furnished with the necessary human and financial resources to effectively manage all facets of the maintenance works.

## 1.2 Types of maintenance

The effective organization of maintenance is based upon the concept of damage control. With timely interventions based on regular inspections of the road network, works are planned and carried out at an early stage to counter the detrimental effects of traffic and weather.

Maintenance work is classified according to its timing or frequency as well as the scale or complexity of activities. Although emphasis is always on preventive measures, there will still be damages that cannot be prevented. Minor repairs are therefore part and parcel of the regular maintenance activities.

Before rectifying a defect, the underlying cause of the problem should be identified. In many cases therefore the corrective activity alone may not be enough, the underlying cause must also be dealt with.

### Routine maintenance

Routine maintenance activities are usually small-scale, widely dispersed, and often performed using manual labour. The need for routine maintenance can to a large degree be forecasted.

Routine maintenance activities are further defined as either *cyclic* or *reactive*, although the distinction between these terms is not always very clear.



Fig 1.1: Routine maintenance of a culvert

*Cyclic activities* are performed at predetermined intervals throughout the year purely as a preventive measure because of events we know will occur (e.g. cleaning drains before and during seasonal rainfall), and are scheduled at fixed times during the year.

#### Common routine maintenance activities

- Remove debris from roadway and drains
- Clear drains, allowing free passage of water
- Clear culverts and other water crossings
- Repair shoulders and side slopes
- Patch potholes, seal cracks and repair edges of pavement
- Cut grass and bush
- Maintain road signage

*Reactive activities* are performed in response to a triggering condition that requires action before the problem gets out of hand (e.g. blocked culvert, crack sealing and pothole patching).

### Periodic maintenance

Periodic maintenance is a major overhaul of the road typically carried out after a period of 5 to 10 years, depending on traffic levels, pavement type and geographical and weather conditions. The work involved is normally larger and require more equipment and specialist skills. As a result, this work is considerably more costly than routine works. The most common periodic maintenance activities include renewal of road surface and major repairs of structures. Periodic maintenance is planned in cycles covering several years, thereby describing when individual roads in the network are due for such a treatment.



Fig 1.2: Road surface showing a history of routine maintenance, now due for resealing.

## Emergency maintenance

Emergency maintenance responds to occasional, unforeseen events such as landslides, washouts, large trees or debris on the road and broken drainage structures. Emergency maintenance can be categorised into (i) temporary restoration works, re-opening safe passage on the road, and (ii) permanent restoration, securing the stability of the road and reinstating all its components to its former (or a better) condition.

Maintenance activities are also categorised based on where the works are located:

**Off-carriageway works** consist of maintaining shoulders and drains, clearing of CD structures, removal of debris, cutting of grass and bushes. The works also include minor repairs to drainage and other structures in the roadside area, maintenance of road signs and pavement markings, side slopes and all surface areas within the road reserve. Off-carriageway maintenance is normally a routine activity.

**On-Carriageway works** relate to road pavement and 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 camber or cross-fall to secure proper surface drainage.

### 1.3 Benefits of maintenance

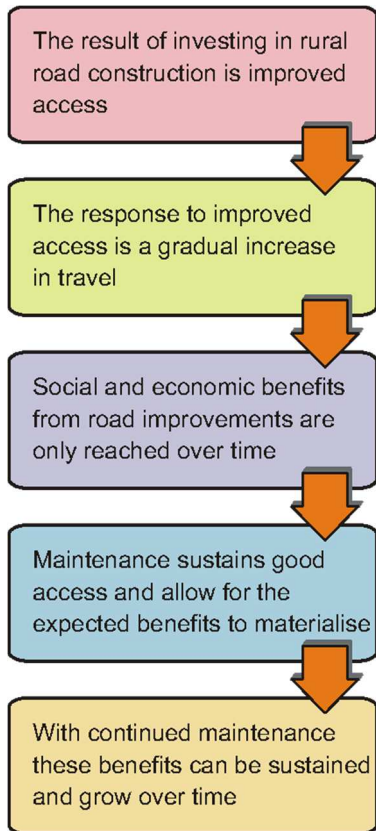
Rural roads are the last links in transport networks and thus form a critical link in terms of providing access for people living in rural areas. Permanent or seasonal absence of road connectivity acts as a crucial factor in terms of denying rural communities access to basic services and economic opportunities.

The social and economic impacts of rural roads are well established.<sup>1</sup> Communities and local governments often attach a high priority to rural road improvements. Rural roads provide access to where people live and

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<sup>1</sup> Ref: Impact Assessment of Pradhan Mantri Gram Sadak Yojna (PMGSY), Ministry of Rural Development (Monitoring Division) New Delhi, 2011.

important facilities such as markets, schools and health services. Good access provides the opportunity for improving livelihoods and increased employment opportunities, thereby contributing to the alleviation of poverty. Although it may be argued that the link between rural roads and poverty alleviation is mostly indirect, experience clearly shows that areas



with poor road access are generally more disadvantaged than areas that are better served. Investments in rural roads can therefore be justified from both a socio-economic and a poverty reduction point of view. Nevertheless whatever benefits they provide are short lived if they are not maintained.

The Millennium Development Goals (MDGs), set clear targets for a number of challenges in different sectors, many of which are closely linked to infrastructure provision. Access to markets and other income opportunities, basic services such as clean water, proper education and health services are directly dependent on establishing proper transport access to where people live.

In short, sustained provision of local roads plays an essential part in improving the livelihoods in rural areas. Although roads as such are not identified as a direct MDG target or

indicator, the provision of such infrastructure is a facilitating measure to achieve many of the MDGs. Without sustainable transport infrastructure, many of these targets will not be met. Although there is a common understanding of its importance, there are still many challenges as related to its provision.

Rural roads have a significant impact on the agriculture sector. Most agricultural development schemes include substantial rural road components as part of the measures designed to boost farming outputs.

#### Benefits of sustained access

- ✓ Owners of vehicles incur lower operation costs and slower depreciation of their vehicles,
- ✓ Reduces the cost of operating public transport services,
- ✓ Users of public transport benefit from reduced travel times, lower fares, higher frequencies, more regularity of services and better comfort,
- ✓ Farmers, entrepreneurs and traders retain access and incur lower transport costs,
- ✓ Improves the business environment for farmers and local entrepreneurs,
- ✓ Rural dwellers get easier access to health services,
- ✓ Children and youth experience easier access to school, resulting in lower drop-out rates,
- ✓ Communities as a whole can maintain social and economic ties to the outside world,
- ✓ Government agencies achieve better access to local communities in terms of providing outreach services such as health, education.

Agricultural marketing boards and similar institutions are often involved in building or financing rural roads.<sup>2</sup> The provision of rural roads in many predominantly agricultural States are often financed through levies on agricultural products. Again this shows the importance of proper road access to sustain rural economies.

The most commonly applied model for calculating the economic rate of return on rural road investments is based on the potential cost savings on transport of farm produce resulting from the road improvements. The importance of adequate roads to transport farm produce is often evidenced by the arrival of wholesale merchants to buy surplus produce when new rural roads have been built.

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<sup>2</sup> The state of Punjab in India produces more than 50 percent of all grains in the country. Taxes on these goods are used to finance the entire rural road network in the state. The State Agriculture Marketing Board manages all the distribution centres for farm products and also acts as a technical agency for rural road construction.

Rural roads have in recent years received increased attention, partly due to a growing recognition to its role in poverty reduction. However it is not the construction of roads that ensures access over time. If roads are not provided with adequate maintenance then their access value will be lost. It is the maintenance applied to roads that provides sustained access and contributes to the improvement of livelihoods and economic development. Furthermore, sustained access builds the confidence required for people to invest in improved farming practices and other business opportunities in the rural areas.<sup>3</sup>

#### **Increase in rural traffic**

The impact of improved road access in rural areas is clearly demonstrated when proper road connectivity is provided to a community. A common scenario for an unconnected rural village is that it does not have any road access at all or at best is connected with a track, open for four-wheel drive vehicles during the dry season. The result of this dire access situation is that transport of goods and people is essentially on foot or with animal drawn carts.

When connected with all-weather roads, it is common to see a significant increase in traffic to and from the communities. While farming and other economic activities normally need time to draw the full benefits from the improved access situation, there is an immediate increase in the number of trips made by the villagers served by the road.

It is important to note the significance of the rural road connecting these communities. Often, the only access to these communities and the only effective mode of transport is provided through a single access road. If this link is not maintained, there is no alternative means of communication. When this connection falls into disrepair, it has an enormous social and economic

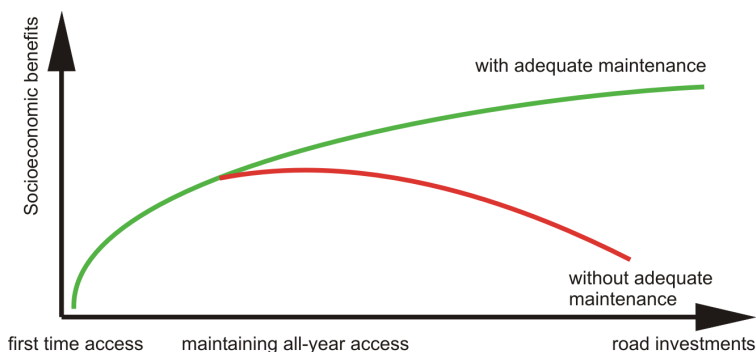
### **1.4 Deteriorating rural access**

Rural roads are important in order to provide the opportunity to realise the potentials of agriculture and other economic activities, facilitate schooling, health services and marketing and satisfy other social and economic needs. If rural roads are not properly maintained, access deteriorates and these activities are negatively affected. Chart below

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<sup>3</sup> Ref: Rural Road Maintenance – Sustaining the Benefits of Improved Access, Donnges, Edmonds and Johannessen, ILO 2007

shows the relationship between investments in road development and socio-economic benefits.



Benefits start emerging when a region receives first time road access, as goods, services and facilities become increasingly accessible. This can bring about substantial economic and social benefits, opening up the area to markets, health facilities, schools, government services, etc. Communities enjoy the benefits from improved access and become increasingly frustrated if the connecting road deteriorates and improvements in their living standards are compromised.

Poorly maintained rural roads incur high transport costs, often resulting in limited profit margins to the farmers. The seasonality of road access, combined with limited storage facilities, causes the deterioration of crop harvests and discourages farmers to produce a surplus.

After a few years, roads without maintenance become impassable to year round traffic. Initially, the deterioration of the roads only leads to increasing transport costs marginally. At some point however, traffic conditions, traffic composition and traffic patterns change as the road becomes increasingly non trafficable and the cost of transportation rises drastically.

It indicates that the initial investments in providing first time access generate the fastest increase in socio-economic benefits, followed by investments that provide all year access (in areas that only have seasonal



access). The smallest increase in socio-economic benefits results from further road improvement and upgrading. Maintenance works sustain and compound the benefits generated, while lack of maintenance results in a significant decrease in socio-economic benefits over time.

A lack of maintenance also affects people's life in social terms. Once roads become non trafficable, people have limited access to schools, health centres or other service centres. It also becomes more difficult for service providers to reach communities, schools and health centres. As a result, the level and quality of such services deteriorate. Teachers are absent more often as schools become more difficult to reach, mobile health teams visit areas less often and the distribution of medicines declines. These negative social impacts have significant long-term economic consequences.



Fig 1.3: Lack of maintenance causing higher vehicle operating costs and increasing costs of transport services

Accessibility and transport services are linked and an important correlation is the one between rural roads and local transport services. Rural people often are too poor to own their own motorized vehicles and depend on public transport to gain access to locations outside their communities.

When rural roads deteriorate managing public transport becomes more expensive and transport operators eventually decide to stop their business. This translates into declining public transport services in rural areas. Transport is a facilitating mechanism and as a result access to social and economic goods and services declines.

## Health and education

Numerous studies have identified the connection between quality of health services and literacy levels in rural communities and the proximity to all-weather roads. With poor roads travel time obviously increases to health centres and schools. When the travel becomes too arduous, many people choose not to use such facilities.

Poor access also has a significant impact on the quality of schools and health services. It is a common feature that schools and health clinics located in areas with poor access are badly equipped as compared with similar facilities in central locations. The reasons are very simple. Firstly, with poor access, it becomes more difficult to maintain and re-supply these facilities. More critical is the fact that qualified teachers and health workers are often reluctant to live and work in such areas with limited or poor access.

## 1.5 Attitude and perception

Maintenance, in particular for rural roads, has always been the poor relation of the road sector. It is often viewed as important only by its absence, when roads deteriorate to the point that they are no longer serving their intended purpose. Road maintenance and in particular routine works often consists of small inputs dispersed across the road network and therefore goes unseen to the general public. The importance and effects of such efforts are generally not appreciated unless significant damages start developing in the road surface.

For this reason, the general public and their elected representatives do not fully appreciate the importance of providing regular and up-front maintenance unless they are properly briefed and made aware of the challenges. Limited tenure of the elected representatives in office may also sway their interest in the direction of using available budgets for more visible improvements in the form of rehabilitation works where roads are admittedly in a bad shape and thereby showing to their electorate that they are bringing significant new services. Preserving the part of the network already in good shape has no glamour and maintaining the status quo can be perceived as not doing enough.

Similar trends are also found in various rural development programmes. Such programmes commonly emphasise the construction of new

infrastructure while giving limited attention to maintenance works. Very few rural development programmes include a sound strategy for how assets being created will be maintained in the future.

Officials or Engineers in the technical units (Road agencies) also have a tendency to favour new construction rather than placing importance on maintenance. This may not be their fault. If maintenance policies are not clearly defined and supported by sound asset management principles, available funds tend to be used to repair or rehabilitate roads that have deteriorated and at times reached the stage that they are in effect unmaintainable. When roads fall into serious disrepair, road agencies tend to receive more attention and pressure to take action.

The absence of a sound road management system is not necessarily due to limited budgets, but can also be a result of inadequate institutional

### Systematic approach

The maintenance of road pavements has never been viewed as a serious issue, till recently, by the concerned and has always been side lined. The ill effects and loss to economy by poorly maintained roads are quite pronounced. The construction of new roads has always got preference over the maintenance of existing roads. It is high time that the maintenance aspects, such as, objective assessment of actual requirements, use of new techniques, proper fund allocations and effective implementation are well addressed. Though, guidelines are available on condition based maintenance, selection of appropriate technologies, quality control, strengthening of weak pavements, etc., these are not being followed in good spirit. Hence, there is a need for a systematic approach in implementing a planned and an adequate maintenance strategy.

*Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, Ministry of Road Transport and Highways, Indian Roads Congress, 2004*

capacity. Often, the capacity to effectively plan and manage maintenance work is limited. In the first place this is manifested through the lack of information on the state of the network. Condition inventories are notable by their absence. In default of this information, it is difficult for those responsible to present reasonable arguments to spend some of the available budgets on preventive maintenance on the core road

network instead of allocating most of the funds to reconstruction and major repair works.

Having a reliable monitoring system that provides up to date information on the condition of the network allows road agencies and political bodies to plan maintenance works in a manner which protects the existing assets from further deterioration and thereby increasing the quality of the road network over time. It is only on this basis that it is possible to argue for (i) sufficient budgets and (ii) obtaining the necessary political support for making the right maintenance priorities.

Road agency units may also be under pressure to spend available maintenance budgets within defined time frames. Periodic maintenance and reconstruction works are more comprehensive compared to routine maintenance, involving considerably larger contracts. Preventive routine maintenance is management intensive as it needs to cover the entire road network on an annual basis. In terms of ensuring that available maintenance budgets are spent before the end of the financial year, it is easier for technical agencies with staff shortages to let contracts for periodic maintenance and reconstruction works as it involves fewer contracts to supervise. Such interventions are also more visible than carrying out preventive maintenance on roads still in good condition.

The general public are of course pleased that roads are provided for them. They will generally not complain about the lack of maintenance but rather about the lack of traffic ability. Road users will usually not voice their concerns before the road deteriorates to a stage where it causes excessive wear and tear on vehicles and eventually becomes non-trafficable. They may understand that the road has deteriorated because of lack of maintenance, however the negative impact of accelerated road deterioration due to lack of preventive maintenance is not fully appreciated. Thus, even though they have the possibility of bringing complaints to local authorities, they would not usually point to the lack of regular preventive maintenance.

The rationale behind any on-going maintenance programme and the underlying priorities are based on a combination of several factors often including the issues mentioned above.

## 2 Current setting

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### 2.1 The rural road network

India has one of the largest road networks in the world estimated at a total length of more than 4.8 million kilometres.<sup>4</sup> This includes all categories of roads as also those in urban areas and those constructed under various employment programmes.

The total length of rural roads is estimated at roughly 3.25 million kilometres. According to a broad assessment made by the MORD, the replacement value of rural roads is Rs. 4860 billion. These are huge assets and justify the application of sound asset management principles to sustain such services.

The poor condition of rural roads also results in an increase in unproductive time spent on the transport of people and goods. Moreover the benefits created through the investments in access improvements for the rural population are being lost.



Fig 2.1: Local road providing essential access

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<sup>4</sup> Source: Basic Road Statistics of India 2011-12, Ministry of Road Transport and Highways, New Delhi, December 2013

This network includes trails, tracks and earth roads built by various rural development programmes and the local authorities. It is not known to what extent these roads are properly engineered structures however, they play an important role in providing access to rural communities. While the PMGSY and other rural road programmes provide access to larger habitations, these unpaved roads provide access to smaller communities. Maintaining these roads is also part of the maintenance challenge in the country.

### Classification of roads

The ownership and responsibility for the public road network is defined by national and state level legislation with regulations and directives derived from this legal framework. The road network is divided into national highways, state highways, major district roads, other district roads and village roads. Rural roads comprise the other district roads and village roads.

In addition, there are urban roads and streets, roads in national parks and forest reserves, border roads, project roads, etc. What is important to note is that the classification primarily relates to their function and to who is in charge of these roads - and not necessarily the technical standards applied.

The rural road network provides the basic access for the rural population to economic and social services (i.e. markets, health, schools and information). The responsibility for rural roads is vested with both the state authorities and the local government (Panchayati Raj Institutions). In some states, there are several agencies at state level involved in rural road works. The Central Government has been providing financial support in construction of rural roads for providing new connectivity and upgradation of existing roads under the PMGSY and PMGSYII.

The poor condition of the rural roads from past rural development programmes and lack of maintenance is clearly recognised by the government. The launch of the PMGSY was for the first time a major rural development programme focussed directly on the rural connectivity issue keeping rural roads of uniform standard as the only deliverable. As a first attempt to deal with the maintenance issue, it introduced a 5-year routine maintenance built into the construction contracts.

### Past rural road works

Rural roads have been built under various rural development programmes. Serious efforts through these programmes also could not provide all-weather connectivity to more than half of the villages in the country. On the other hand, many roads which have been built could not be sustained. Careful examination of these has revealed that most efforts have not been effective due to the fact that in those programmes, the roads were not understood to be engineering structures. These non-engineered structures without backup systems and facilities to sustain them with engineering inputs for repair and maintenance have disappeared in no time. Many of the technical aspects of road building were never given due importance in rural roads; e.g. adequate compaction of sub-grade, drainage, required cross drainage and a host of others. There must not be any inhibitions about the technical details that are required to be understood for rural roads; these are required to be adopted necessarily. But none of these are impossible to adopt for local agencies and authorities by any means. Moreover there are plenty of appropriate technologies for rural road construction and maintenance using locally available materials as well as local agricultural implements.

*From the Rural Roads Manual, Indian Roads Congress 2012*

At the time of launch of the PMGSY in 2000, there were around 347,000 habitations without an all-weather road connection. The intention of the PMGSY is to provide all habitations with a population of more than 500 with all-weather rural road connectivity. In the case of hills, deserts and tribal areas, the threshold is relaxed and covers all communities with a population of 250 inhabitants.

As of August 2014, the value of works sanctioned is Rs. 1835 billion covering both new construction and upgrading, benefiting a total of 145,000 habitations through upgrading 198,000 km of existing roads and constructing 360,000 km providing new connectivity.

The PMGSY programme started construction activities about thirteen years ago. There are more than 100,000 km that have finished the 5-year maintenance contracts and the first roads are now due for periodic maintenance. In the years to come, more quality rural roads will need to be adopted into a well-managed maintenance system in order to protect

these investments and thereby sustain the benefits of this new generation of rural roads.

The Government is becoming increasingly concerned with the long-term maintenance of these assets. The Thirteenth Finance Commission provided targeted central grant funds (Rs. 199,300 million over a period of four financial years 2011-15) to support state agencies in the provision of routine maintenance for state roads including PMGSY.

But allocations of resources and functions within the states down to local governments are still evolving and often inconsistent with institutional capacities at the local level. To effectively utilise these funds, there is a requirement for an overarching strategy for delivery of maintenance activities and to more closely monitor the use of funds allocated.

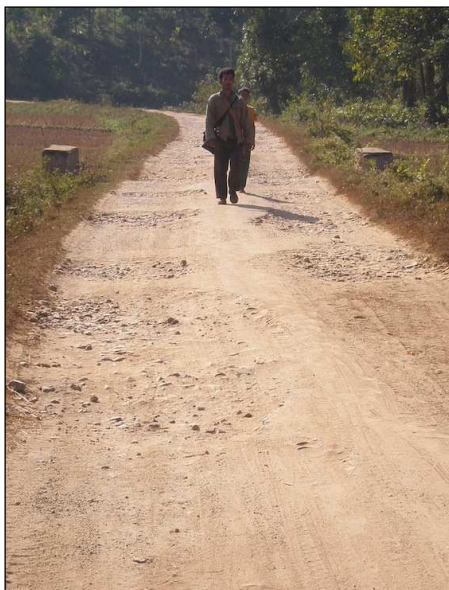


Fig 2.2: Lack of preventive maintenance resulting in road surface deterioration

## 2.2 The maintenance challenge

The maintenance of rural roads is becoming an increasing challenge as a result of the rapid growth of the network. Furthermore, some states experience a rapid growth in traffic volumes on their rural roads, which in turn warrants more frequent maintenance inputs. These developments need a structured approach to road maintenance in order to secure that the necessary inputs are provided on a timely and regular basis, thereby protecting the investments made to extend connectivity into the rural areas.



Unfortunately, only a small portion of the rural road network receives regular maintenance. Sound management systems have been established for the portion of rural roads falling under the jurisdiction of some state road agencies. Even within this cluster, the situation is not ideal, as these rural roads need to compete for maintenance funding with the state highways and major district roads. This picture is further compounded by the fact that many state road agencies are yet to establish sound management practices for their networks.

### Maintenance of PMGSY roads

A PMGSY audit of maintenance activities estimated that only 30 percent of maintenance requirements are met for the network as a whole and even under the five-year maintenance contracts surveys reveal that only 25 percent of roads are fully maintained with 30 percent not receiving maintenance at all.



Fig 2.3: Reaping the benefits of improved access provided through the PMGSY

Maintenance of the remaining rural road network is extremely unsatisfactory. Many roads built by various rural development programmes do not have an institutional home. Roads built by or in collaboration with the Panchayati Raj Institutions should be maintained by these authorities. While in some states, PRIs are supported with technical departments and state funds, other PRIs need to be similarly supported with the necessary technical and financial resources. NRRDA



Fig 2.4: Rural road deteriorated to the extent that full rehabilitation is required.

has taken the lead in imparting training to technical staff of PRIs and Rural Engineering Departments.

The challenge of maintaining the rural road network is recognized by the government. The 12<sup>th</sup> Finance Commission considered the issue of maintenance of state roads and bridges by the state governments. In its Committee Report, it stated: *“It is far more important to ensure that assets already created are maintained and yield services as originally envisaged than to go on undertaking commitments for creating more assets. We notice that maintenance of roads and bridges has not been given adequate importance by the states. We are, therefore, recommending additional grants separately for maintenance of roads and bridges, and maintenance of buildings.”*

Similar central grants were recommended by the 13<sup>th</sup> Finance Commission. To quote from its Report *“A proper road infrastructure is vital, not only for economic development but also for better delivery of services such as education and health. There is evidence to show that road networks lead to, among other things, improved teacher attendance, quicker medical attendance and a greater number of institutional deliveries. We hope that the enhanced provisioning for maintenance, including the focus on the newly created PMGSY roads help in sustaining road connectivity”*.

The maintenance challenge is however not only a matter of securing adequate funding. Sound asset management principles need to be introduced as an integral part of rural road policies and maintenance programmes thereby protecting investments already made in improving rural roads. Ensuring that available budgets are utilised in an effective manner essentially implies that work programmes adopt a preventive approach to rural road maintenance. This requires an intimate knowledge of the road network, obtained through regular inspection and monitoring. On this basis, it is possible to prepare comprehensive maintenance programmes that ensure that the network does not deteriorate over time. A structured approach to planning is a key component of any effective maintenance management system.



Fig 2.5: Recording the condition of a road

The planning process needs to be followed up by effective arrangements for implementing the works. Although the technology and work activities are not much different from construction works, rural road maintenance works is spread over a large geographical area requiring continuous and concurrent inputs at numerous locations. This places specific management and supervision demands on the agencies in charge

### Road maintenance management systems, RMMS

Some states have made good efforts in establishing sound maintenance management systems, some of which are fully computerised. There is no lack of competence to operate such systems. In many places however, the challenge seems to be in sustaining the commitment to operating a programme based on a systematic approach to maintenance based on sound asset management principles. In this context, experience clearly show that sound management procedures are not dependent on technology but on the political will and discipline in the relevant agencies to pursue a maintenance approach that give priority to protecting existing road assets.

of the works. It also implies that works need to be organised in a different manner as compared with road construction activities.

From the above, it is clear that there are challenges both in terms of funding as well as capacity development. These sentiments are also reflected in the government policy

document “Rural Road Development Plan: Vision 2025”. This document summarises some of these challenges as follows:



Fig 2.6: Regular inspections form the basis for effective maintenance management

- There is multiplicity of agencies handling the work of rural roads. Except for PWDs and some rural engineering organizations, practically no funds for rural road maintenance are allocated. There is no clear ownership of rural roads being built except under the PMGSY where five-year routine maintenance is ensured through state governments formally allocating funds for the purpose. A few states have taken initiative recently in setting up dedicated funds for roads. Uttar Pradesh and Karnataka have road fund only for maintenance. Some other states have set up road funds for both development and maintenance. As a result, budget allotments for maintenance are now showing an upward trend. But there is still a wide gap between availability of funds and those required for proper maintenance.
- There is virtual absence of an institutionalised system of inventory and condition survey and planning and management system for rural roads, which can identify and prioritise maintenance interventions for the core network.

- The PRIs are not raising any funds for maintenance. Although they are expected to be ultimately made responsible for maintenance, they are not being provided with funds for maintenance by the state. Moreover, except in a few states, they do not have any technical support to undertake such activities.
- About 80 percent of rural roads are in poor condition due to a combination of several factors, lack of funds and poor quality of construction. The culture of quality construction of rural roads is now improving with the PMGSY setting up three tier-control in this direction. Attention to drainage and compaction of various layers of embankment and pavement will also help in reducing the maintenance burden.

#### Vision 2025

The challenge before us is both expansion of the network to provide road links to unconnected habitations and at the same time maintenance of the existing vast rural road network built at huge cost to the economy over the past over fifty years. A balance between road building and road maintenance has to be achieved. Timely upkeep and maintenance would help in availability of roads for passage of traffic continuously particularly in monsoon, reduce time of travel besides reducing rate of deterioration and adding to safety of road users.

For sustainable maintenance of the road assets, strong political will backed with administrative and technical support is required. There is evidence of increasing awareness and commitment to maintenance by the States in the recent years. The tempo needs to be built up and continued.

Among several issues to be addressed for ensuring maintenance of rural roads on a sustainable basis, the most critical identified in the Vision 2025 document are:

- *Government policy:* A firm policy and commitment of the government in the states to maintain the rural roads to serviceable levels all the year round. Preservation of existing road assets has become a matter of critical importance. The state governments would need to provide full funds under non-plan for maintenance as per recommendations of the Finance Commission from time to time.

- *Dedicated funds*: A dependable and adequate flow of funds on continuous basis to enable the road agencies to effectively plan and implement their maintenance programmes.
- *Maintenance backlog*: Finding ways and means of phased removal of the backlog of periodic maintenance and bringing the roads to maintainable situation.
- *Linkage to initial construction*: Ensuring proper design and quality construction in the first instance as this would reduce the maintenance burden subsequently.
- *Maintenance management system*: Improving maintenance planning and accountability through creation of road registers, setting up database and simplified maintenance management systems so as to optimize use of allocated funds and prioritize maintenance interventions, with first charge on the core road network.
- *Institutional reforms*: Strengthening institutional arrangements through productivity improvement of gang labour, tightening supervision and monitoring and auditing arrangements, training of personnel to improve local skills.
- *Contract maintenance*: Introducing innovative ways of execution of maintenance works such as encouraging creation of micro-enterprises and labour cooperatives.
- *Panchayati Raj Institutions*: Building up the capacity and capability of Panchayati Raj Institutions to undertake the maintenance of rural roads. Providing technical support to these institutions.
- *Modernization*: Modernisation of maintenance operations, introducing low cost equipment for pothole repairs, grading and use of modern materials.
- *Experience sharing*: Regular awareness programmes of what works and what does not work. Documentation of successful strategies and dissemination through publications, workshops at state, national and international levels.

## 3 Financing rural road maintenance

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### 3.1 The challenge

The challenge of mobilising sufficient resources for road maintenance has been on-going since modern road works technology was developed. Already in the 19<sup>th</sup> century it was acknowledged that effective maintenance required skilled organizations and that adequate funding was allocated to pay for such services. Until then governments had to a large extent relied on various forms of obligatory contributions from landowners as a means of securing a minimum of maintenance.

Finance, or the lack of it, has traditionally been the main excuse or reason for roads not being maintained. Lack of funds is certainly a major obstacle in many places. However, recent studies show that the ineffective use of available funds can also be a major contributor to the deterioration of the road network. Rather than giving preventive maintenance its due recognition and prioritising funding to the maintenance of roads still in good condition, the trend is often to spend available funds on repairing roads which have been left unattended too long and which has deteriorated into a poor condition – at which time maintenance becomes very expensive.

From an asset management point of view, such decisions lead to an ineffective use of available resources. Road construction is considerably more costly than maintenance works. Providing maintenance at the time when defects are still limited is a much more effective way of using scarce resources. This implies that before embarking on a programme of extending or upgrading the network it would be logical to first ensure that existing roads are kept in a good condition.

The challenge is however not as easy as it sounds. Networks consist of roads, some of which are in good or fair condition while others have deteriorated to the extent that they are not passable. In this scenario, there is a strong pressure to give priority to the roads that have fallen into total

disrepair, leaving the roads in good or fair condition to be attended at a later stage. The problem with this approach is unfortunately that this process has a tendency to repeat itself during the following construction seasons, again leaving good or fair roads without any attention and exhausting available budgets on costly reconstruction works. Over time, this leads to a heavy maintenance backlog and to more and more roads requiring emergency reconstruction.

### Addressing all demands

The costs of maintaining rural roads are well known. Equally, it is evident that there are no short cuts past the funding issue. The cost of maintaining a rural road network is directly proportional to its size. With a chronic shortage of funds, it is often suggested that the size of the road network needs to be limited. Since rural roads constitute the vast majority of roads in a given network, it may be argued that the number and extent of the rural roads should be limited.

With the continued demand for access in rural areas, authorities are therefore left with the tough choice of either providing new road connections (which eventually fall apart) or maintaining already existing roads. In many places, all-year rural road access is still only provided to a limited portion of the rural population. Unless sufficient funds are mobilised for a sustainable expansion of the network in which there is enough resources for both new development (and reconstruction) and maintenance, the practice of diverting maintenance funds to construction activities will continue.

The challenge for managers is to break this vicious circle and instead introduce a more preventive approach to maintaining the network. While there is always a need for some emergency works, it is crucial that adequate budgets are also set aside for preventive works on the roads that remain in a good or fair condition. Considering the large backlog of maintenance in many places, this may appear as a daunting task. Still, it is the only feasible approach to halting a gradual deterioration of a road network.



## 3.2 Funding confidence

Roads are resource-intensive to maintain compared to other infrastructure such as water supply and buildings. Often, it has a poor record of transparency and its financing can appear as a seemingly bottomless pit. Despite the resources allocated to maintenance, roads seem to fall apart while the road agencies continue asking for more funds. As opposed to construction works, the budgets allocated to maintenance do not create any new assets - it only preserves what is already in existence.

### Giving maintenance its due attention

The maintenance of road pavements has never been viewed as a serious issue, till recently, by the concerned and has always been side-lined. The ill effects and loss to economy by poorly maintained roads are quite pronounced. The construction of new roads has always got preference over the maintenance of existing roads. It is high time that the maintenance aspects, such as, objective assessment of actual requirements, use of new techniques, proper fund allocations and effective implementation are well addressed. Though, guidelines are available on condition based maintenance, selection of appropriate technologies, quality control, strengthening of weak pavements, etc., these are not being followed in good spirit. Hence there is a need for a systematic approach in implementing a planned and an adequate maintenance strategy.

*Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, Ministry of Transport and Highways, Indian Roads Congress, 2004*

It is therefore understandable that funding authorities have some reservations against allocating money to this activity. The combination of institutionally weak recipient organizations and a lack of reporting on the use of maintenance funds may further erode confidence among the decision makers who are requested to allocate funds for this purpose. Also, due to the lack of institutional capacity in some organizations charged with rural road maintenance, there may be very limited documentation supporting the need for increased maintenance allocations.

Very few maintenance programmes have good reporting systems that actually detail the specific needs for maintenance in terms of specific

activities at identified locations along the road alignment. In many places, there are no up-to-date inventories of the road networks. Equally, for the budgets made available, there is seldom any reporting on how road damages have been rectified and how funds were spent.

The issue of funding confidence is also a concern for the road agencies. In the absence of up to date road condition inventories, budgeting for maintenance is not based on the real maintenance requirements but instead based on previous years budgets and an assessment of what increases can be expected in the forthcoming annual budget. Most road agencies are able to provide reasonable estimates of the required budget however, since the budget allocations provided are significantly lower than the requirements there is a tendency to lower the demands when preparing annual work plans.

Where budgets have been allocated, they are sometimes not utilised for the maintenance of those roads but on improving other roads. In addition, the implementing units do not always use the allocated funds as per priority of maintenance required. As such, it is not difficult to understand that finance ministries and treasuries have certain reservations against putting money into road maintenance. It is, however, possible to carry out this work in a transparent and well-documented manner. With proper road condition inventories, it is possible to draw up comprehensive and detailed work programmes clearly defining the work activities against which budgets are allocated. During works implementation, it is possible to specify contracts to sufficient level of detail, clearly documenting where and what work should be carried out. With sound inspection procedures and payment based on performed outputs, the progress of work can be properly verified and expenditure related to specific work outputs. Without this, it is difficult to instil the necessary funding confidence within the relevant financing authorities.

Structured programming and supervision arrangements do, however, require a professional organization in which such procedures are institutionalised. It needs a team of competent staff with the relevant technical, financial and administrative skills and the logistical means to supervise the works, thereby achieving the level of transparency and good governance which is today expected by funding authorities.

Without this capacity within the executing agencies, releasing the required funds for maintenance runs the risk of money not being spent on its intended purpose.

### **3.3 Funding sources**

The traditional approach to funding the cost of building and maintaining roads is through the revenue base coming out of the regular tax collection system of the government. Realising that roads are expensive to build and maintain, most countries have introduced vehicle licensing fees and fuel taxes to increase revenue. Still, such funding mechanisms are often insufficient to cover the full needs of the road sector. Secondly, the revenue collected through this taxation system is also used to cover other government expenses outside the road sector.

Funding for road maintenance can be generated from a variety of sources. In most cases, the funding for maintaining highways and local roads is provided through subventions from state or federal government, using revenue from the regular taxation system. The ability to raise sufficient taxes and revenue at local level is limited and in recognition of this, central governments are in most places the main financier of local roads.

Road maintenance is normally financed through the government recurrent or non-plan budget, which is the main source of funding the operation of public services. Unfortunately, experience shows that budget allocations for road maintenance are often insufficient. For this reason, various arrangements have been devised to seek additional revenue that is specifically earmarked for the financing of road works.

To address funding shortages there are some alternative financing sources that can be utilised, such as vehicle licensing fees, cess on agricultural produce and earmarked taxes on fuel. Some states have established arrangements in which specific tax revenue is collected in dedicated road funds, thereby providing additional funding to maintain

roads. Equally, the union government has established a fund used for financing road works activities.<sup>5</sup>

In recent years, public private partnerships have become popular arrangements for financing maintenance and operation of major roads and highways. These schemes predominantly utilise user toll fees collected directly from the traffic. The public private partnerships models and toll financing applied on high-volume roads are not effective on rural roads because of low volumes of traffic.

Sourcing money for rural road maintenance is more challenging due to the specific nature of rural roads. Rural roads commonly constitute some 70 to 80 percent of the total length of the public road network. The maintenance of such an extensive network of infrastructure assets creates a significant financial challenge in itself. Although rural roads have moderate levels of traffic, and therefore less wear and tear, they still need regular maintenance to prolong their life and continued availability of access.

### Local revenue collection

Rural roads form an important part of the social benefits provided to sparsely populated areas in a similar fashion as health and education services. In order to provide such services to rural areas, it is therefore generally recognised that there is a need for external financing to fund both construction and maintenance of rural road networks.

Still, it is argued at times that whilst financial support is provided for the construction of roads in rural areas, it is the responsibility of local authorities to maintain such assets once they have been built. Such arguments are fraught with a lack of recognition of the realities on the ground. In many rural areas there is simply not a sufficient revenue base for the funding of road maintenance. Although road maintenance is less costly than construction works, it still requires significant budgets, at levels often beyond the means of local communities.

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<sup>5</sup> The Central Road Fund established by the Union Government is financed from levies on petrol and diesel, utilised for funding amongst others highway maintenance and rural road construction.



Fig 3.1: Rural road providing valuable local access

## Tax on agriculture

The main economic beneficiary of rural roads is the farming sector. In several states, arrangements have been put in place to tax the sale of agricultural products, specifically to finance the development and upkeep of rural roads and provision of markets, cold storages, etc.

In rich farming areas, the provision of rural roads is recognised by its users as an important support service for the effective transport of produce to local markets centres. It is then possible to obtain the support of the farmers to finance rural road maintenance through levies on agricultural products. As a result, agricultural marketing boards and similar institutions are involved in building or financing rural roads.<sup>6</sup> Such arrangements are feasible in areas with a wealthy farming sector with a significant surplus of agricultural produce. Farmers and plantation owners are then prepared to invest in improved road access as it enables them to fetch better prices for their produce and easier access inputs such

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<sup>6</sup> Since the 1970s, the states of Punjab and Haryana have financed rural road construction and maintenance works from taxes on agricultural goods. The state agriculture marketing boards or *Mandi Parishads* manage the distribution centres for farm products and also act as the main technical agency for rural road works. Similar arrangements are found in Uttar Pradesh and Madhya Pradesh.

as equipment, fertilisers and extension services. In areas with limited agricultural yields, the upkeep of rural roads needs to be financed from other sources.

### Tax on mining operations

There is a significant amount of rural roads that caters to heavy commercial vehicles engaged in transporting materials from mining areas and stone quarries. This type of traffic causes a heavy wear on the local road network. Systems have been introduced in which the government have imposed a levy on the minerals or the trucks involved to finance the maintenance of local roads. Similar arrangements are also worthwhile considering on rural roads into forest areas and used for the transport of timber.

### Road funds

Road funds are based on the argument that road users should pay for the services provided in the form of a well-maintained road network. Whilst the actual organization of the road funds may vary, the basic principles apply to all. A specific levy is applied on fuel and is used to finance road works.<sup>7</sup> The money is placed in a dedicated account and administered by an independent body with representation from road users, government and private sector. Several states have already established such a funding



Fig 3.2: Providing essential access to farming areas in Punjab

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<sup>7</sup> The major source of fund for development of rural roads is now the Central Road Fund. Currently, out of the total cess of Rs.2.0 per litre on petrol and diesel, a component constituting 75 paise per litre on diesel is earmarked for development of rural roads.

mechanism and more states have recently taken the initiative of setting up similar funds for roads. Some states, such as Uttar Pradesh and Karnataka have road funds dedicated for maintenance only. Other states have set up funds for both road construction and maintenance.

The challenge with these funds is to protect them from other use by the government. Secondly, it is important to establish a mechanism that ensures that a minimum portion of the proceeds is allocated to the rural road network.

Several states collect taxes on fuel and agricultural produce that are earmarked for the upkeep of their road networks. These sources of funding constitute valuable contributions to the financing of road works. With an increasing road network and also rising traffic volumes, budgetary needs are growing for financing road maintenance. As part of the strategic planning for the road sector, it is therefore important to continuously assess how these revenue sources contribute to the overall funding needs for maintenance and the growing challenges in this respect. Experience show that the levels of these taxes are fixed at the time when they were introduced but have not been adjusted for cost increases and the growing demands for financing.

### **Convergence with MGNREGA Scheme**

Poverty alleviation and employment creation schemes can also be used as a source of funding for maintenance, and in particular routine maintenance works as it involves many work activities that are best carried out using manual labour. The Mahatma Gandhi National Rural Employment Guarantee Scheme, MGNREGS, offers temporary jobs for unemployed people in the rural areas. Through collaboration with such schemes, road agencies can enter into co-financing arrangements in which they provide inputs of materials and equipment while the employment schemes fund the labour component. Equally, if the technical agencies provide adequate technical support, it is possible to ensure that works are well organised and produce tangible outputs.



Fig 3.3: Village road built with inputs from MGNREGS

Such arrangements can prove effective for routine maintenance works which involve many activities that are best carried out using manual labour. Furthermore, this arrangement is attractive for both the road authorities as well as the agency in charge of the employment scheme. Labour recruited for such purposes also lead to increased involvement of communities in the upkeep of local roads.

MGNREGS and other rural development schemes also build rural roads that require regular maintenance. For any infrastructure asset developed through these schemes, there is a need for providing regular maintenance. As mentioned above, such work can provide significant employment generation and cash income in poor rural areas – on a regular basis – since the maintenance works are required every year.

### **Community mobilisation**

Many attempts have been made to transfer the maintenance burden to local communities. It is fair to point out that self-help schemes for maintenance of public roads have been distinguished by their lack of success unless funding is provided by the government. Despite major efforts in pilot projects to mobilise communities for this purpose,



experience shows that it is difficult to sustain such arrangements in the long term without relying on external financial assistance.

### Community contributions

Drawing contributions from local communities for local infrastructure provision is a well-known concept successfully applied in schemes such as water supply, irrigation and public buildings. It has also been used with some degree of success for the construction of local village roads. Great caution should however be taken in assuming that what works for water schemes and building works can also be applied for road maintenance.

Significant efforts have been made in rural development programmes to set up systems in which the responsibility for maintenance of village roads, *and its financing*, is transferred to the communities. The rationale behind these attempted schemes has been that when there are insufficient funds to maintain local roads the only alternative is to rely on self-help schemes in which the communities are mobilised.

The experience is, however, that roads are much more resource intensive to maintain than other infrastructure such as water supply and buildings, and therefore becomes difficult to sustain through such community contributions. The lack of success in sustaining these schemes clearly shows the need for significant inputs, both technical and financial, to secure adequate maintenance of any type of road.

Management responsibility for a road is linked to its ownership. Here it is important to distinguish between community infrastructure and what forms part of the public road network. Although rural roads are often improved through community development programmes, it is important to bear in mind that the majority of rural roads actually forms part of the public road network. As a consequence, the ownership and responsibility for its operation is already vested with the government.

Despite this, it should be recognised that there are local actors such as religious trusts, philanthropists and corporations which may take interest in providing improved local road access as part of their support to local communities. This should be encouraged but also include the important aspects relating to maintenance.

## Finance Commission

In recent years, the Finance Commission has recognised the need for central assistance to the States for financing road maintenance and made significant allocations for this specific purpose including those for rural roads, through the PMGSY and other rural road programmes.

Side by side of funding mobilisation, an effective management system needs to be put in place together with adequate number of skilled technical staff. Without this, there is risk that available funding is not spent according to its intended purpose. Not only does it result in a continued deterioration of the road network, it also leads to reduced confidence in the responsible road works agencies and the risk of reductions in budget allocations for maintenance works. On the other hand, if there is a competent agency in charge with sound management systems in place, providing quality maintenance works, then authorities are prepared to invest more in protecting the road network.

### Adequate funding of routine maintenance

An expenditure tracking study carried out by the ILO in 2014 concluded that with the current level of Grant in Aid received from the Finance Commission, there is sufficient funding for the provision of routine maintenance on the maintainable portion of the rural road networks. Still, evidence from recent field surveys shows that routine maintenance practices vary considerably in the states covered by this study.

Some states have installed sound arrangements for providing routine maintenance while other states hardly carry out any routine maintenance at all or limit such work to the road surface, leaving shoulders and the drainage system unattended.

This clearly demonstrates that funding is not the sole determinant for the establishment of sound maintenance arrangements. In order for preventive maintenance to take place to required levels there is a need for a clear policy framework and supporting implementation arrangements reflecting the strategies and priorities set out in the policies.

## 3.4 Preparing a financing plan

Lack of funding for maintenance is endemic in the road sector in most countries. With growing road networks, as a result of expanding road

connectivity, and increasing traffic volumes, funding for rural road maintenance becomes a growing challenge. When available funding sources are not meeting the demands for maintenance resulting in an overall deterioration of the road network, it is important to (i) establish the magnitude of the shortfall in funding, and (ii) explore additional revenue sources. The table on the following page summarises the most common revenue sources with their strengths and weaknesses. This table also attempts to provide a ranking of the viability of the various financing options.

Although the ranking presented is the general trend, there may be some variations depending on the particular situation in each of the states. The preferred financing arrangement is through the regular state and federal taxation systems. When these do not suffice, experience show that leveraging dedicated taxes on fuel is the preferred second option since it is easy and inexpensive method of generating additional revenue. All the same, it is important to acknowledge the significant contributions that can be provided from taxes on farm produce, mining industries and vehicle licensing. Equally, rural development programmes with a well-defined maintenance component can become a major actor in terms of preserving rural road assets and at the same time generate a significant number of local jobs.

Many states have already embarked on several of these approaches and today rely on various sources of revenue to finance its road maintenance. The need for financing however needs to be continuously assessed and balanced off in line with growing maintenance demands resulting from an expanding road network and increases in traffic volumes.

Unfortunately, experience shows that it is easier to introduce a specific road user charge and other earmarked taxes than to adjust these charges on a regular basis. Essentially, the sector needs a financing plan which is updated on a regular basis, thereby ensuring that the available revenue sources are sufficient to meet maintenance demands. This process needs to be primarily driven by the state governments as the specific demands and potential revenue sources are best known at this level. Still, considering the magnitude of funding requirements and the ability to generate local revenue, many resource poor states may need financial support from federal sources, similar to the current arrangements in

Common funding options for maintenance			
Rank	Funding source	Strength/justification	Weaknesses/Challenges
1	Regular government recurrent budgets	Roads are part of public services. Providing maintenance is the continued commitment to such service delivery by government.	Insufficient allocations. Ineffective use of available funding.
2	Fuel taxes	Funds made available exclusively for road maintenance and cannot be diverted to other purposes. Easy to collect. Maintenance is funded by direct taxation of the road users.	Reluctance to introducing new taxes. Difficult to adjust.
3	Vehicle licensing fees	Direct taxation of users. Can be designed to be progressive, based on vehicle weights and charging more for commercial vehicles.	More tedious to collect. Shown to be a limited source.
4	Tax on farm produce	Successful in areas with high agricultural production. Relatively easy to collect and can be earmarked for farm access roads. Can be managed by the farmers' associations.	Only feasible where there is a significant production surplus.
5	Tax on quarries and mining	Can be used in particular areas with mining activities or production of bulk materials such as stone aggregate, minerals, coal, cement, etc. Places the maintenance burden on heavy road users.	More difficult to collect. Funds need to be used for maintaining particular roads with heavy traffic.
6	Rural dev. schemes	Employment generation schemes can create long-term employment opportunities by engaging in routine maintenance works.	Need collaboration between agencies. Can cover off-road maintenance
7	Local taxation	Using local government income to fund access roads reflects community priorities.	Insufficient resource base in poor/small communities.
8	Road tolls	Taxation is directly linked to the usage of roads. Used successfully on high volume roads. Not appropriate for low volume roads.	Can divert traffic to roads without tolls.
9	Community contribution	Communities take their own initiative to finance, build and maintain access roads when government does not provide such services.	Difficult to sustain. Places heavy and unfair burden on resource weak communities.

which federal funding is used to support maintenance of state roads and construction of rural roads.

Several states have already established a variety of arrangements to source funding for road sector activities outside the general taxes collected by government (i.e. market taxes, fuel levies, road tolls, fees on particular industrial goods, etc.). In many cases, these alternative revenue sources provide substantial funding for the road sector. At this point, the challenge in some of the more wealthy states is therefore to establish a viable financing plan, which is matched with the total needs for maintenance – also addressing the full needs of the rural road network. For this to take place however, there is a need to (i) establish the demand for road maintenance based on sound asset management principles and (ii) institute sound procedures for maintaining roads based on the same approach.

When funds are generated from alternative sources, it is important that existing allocations from regular government funding sources are maintained and not reduced when other means of financing maintenance are introduced. The main purpose of establishing new sources of funding for maintenance is essentially to cover a shortfall and thus protect existing road assets.

Not all states are blessed with the same wealth of resources and thus warrant continued support from central government to provide and maintain adequate access in rural areas. In effect, the Union Government has been the main financier of rural road construction through various rural development programmes and in more recent years through the PMGSY. Once the network matures in the low connectivity states, there will probably be a need for continued support from the centre, shifting the emphasis from new construction and upgrading works to maintenance. This is already recognised by the central government through the additional central grant for maintenance of state roads including rural roads by the 12<sup>th</sup> and 13<sup>th</sup> Finance Commissions.

While financial support can be sourced from the centre, it is however crucial that the requisite management capacity is established at state level

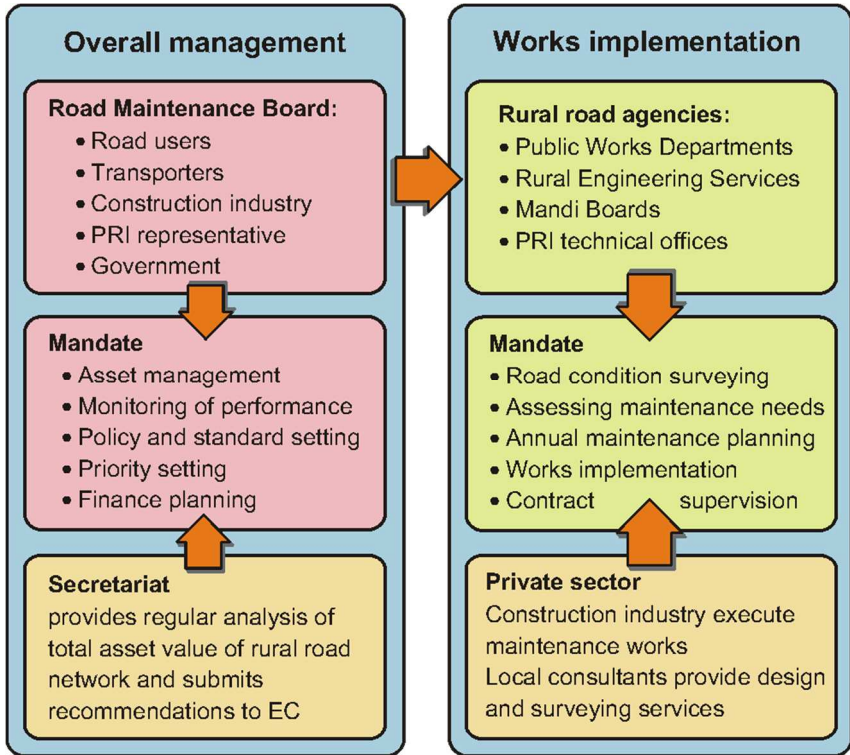
in terms of planning, management and implementation of maintenance works.

### **3.5 Managing road maintenance funds**

The road sector has to compete for funds against priorities relating to health, education and other public services. Road maintenance, being a comparatively expensive undertaking, makes it vulnerable to under-spending in the context of annual budget debates. A response to the growing shortage of finance has been to introduce earmarked road related taxes and charges and depositing these into a special off-budget account, or road fund, to support spending on roads. The basic argument behind this concept is that users may be prepared to pay a specific user fee if they are certain that the funds generated is used to improve and maintain the road network.

Emerging from this process has been the establishment of so-called “second generation” road funds in many countries. A major feature of these road funds has been the creation of a well-defined regulatory framework to assure proper management of the funds and that the revenue is used for its intended purpose. Second generation road funds are governed by a management board with representatives from the users, the construction industry and government, which is tasked with the oversight of how funds are utilised. This board is in charge of securing adequate resources and channelling these funds to the relevant road agencies.

An important feature of the management of these road funds has been the desire to establish a more commercial approach to road management and financing with sufficient autonomy to operate without interference in day-to-day management. The mandate and detailed regulatory framework is thus formed with the intention that the funds manage to operate with limited political interference.



A major feature of this arrangement is the clear split between the overall management of the network and the implementation of maintenance works. The management board is tasked with assembling a financing plan including user fees, state and federal government funding and other sources and setting the right priorities of work which is in line with sound asset management principles. This plan should be evaluated on an annual basis in terms of its effect on the total asset value of the road network. The objective of this process is to ensure that the available funding actually protects the existing assets and at least avoid any deterioration of the network.

The maintenance management board would secure proper representation of the beneficiaries of the road network such as local communities, farmers, merchants and transport companies, thereby establishing a

direct accountability to the users from whom the maintenance taxes are drawn. In addition, key representatives of state government authorities and the PRIs need to be part of the board.

Road agencies and public works departments, on the other hand, are responsible for programming, procurement and management of the road works and for the supervision and payment of contractors executing the works. The planning of works needs to follow the policies and priorities set by the management board, again clearly demonstrating that sound asset management principles are adhered to. Actual works are executed relying on current practice involving the private sector and where available the departmental labour force.

In order to carry out a regular evaluation of the performance of the maintenance programme, it is useful to establish a monitoring unit that collects road condition data and on this basis keeps track of the overall status of the network. This information forms the basis for estimating future maintenance demands and allows for adjustments to the maintenance programmes to ensure the most effective use of available funding.

### **3.6 Funding priorities**

Trunks roads always receive the highest priority when allocating funding for maintenance. Highways and major roads are more expensive to build and therefore justify higher priority when allocating maintenance budgets. Due to the high levels of traffic, they are costlier to maintain and also deteriorate faster when provided inadequate maintenance. Similarly, priority is given to maintaining secondary roads before the requirements of rural roads are addressed. The danger with this approach is that when resources are scarce, most funding tends to end up being spent on the main roads leaving little left to maintain rural roads.

It is therefore important to see rural roads as an integral part of the network. Transport access to local communities consists of the combined services of major roads and the rural road network. Rural roads provide the last section of access to local communities. Often, it is the only connection available. A disruption in this service renders local



communities cut off from the outside world. The very purpose of rural roads is to provide access to basic services and more economic opportunities.

When roads deteriorate to the extent that they are no longer passable, these basic services and economic opportunities are no longer available to the communities. Rural roads built to proper technical standards are equally vulnerable to poor maintenance practices. It is equally important that rural road maintenance is given due attention.

The provision of rural transport access is very much a matter of equitable growth. Rural roads are often extended to poor communities in order to improve access to health, education and economic opportunities. These groups are the ones who first lose out when budget allocations are insufficient to maintain roads.

The integrity of the road network needs to be addressed as a whole including the rural roads. Roads built under different programmes (i.e. PMGSY roads and non-PMGSY roads) need equal attention, as they all constitute important links in the transport network.



Fig 3.4: Providing rural access in Madhya Pradesh

## Consistency in investment decisions

During construction and improvement works, priority is given to roads that provide the highest user benefits. These priorities are based on both social and economic considerations. A comprehensive set of guidelines has been developed for the selection and prioritisation of rural road investments.<sup>8</sup> As part of this process, it is important to note that a key assumption is that these roads will be maintained, thereby allowing for the expected benefits of the infrastructure investments to materialise. Given that the roads were subject to a political and socio-economic process of prioritisation at the time when they were built, there is no reason to repeat this exercise when preparing a road maintenance programme. The decision has already been made to provide connectivity to the communities served by the road. Providing maintenance then becomes the final input in order to reach the intended purpose of the initial investments.

On this basis, there is therefore no need for a second prioritisation exercise, determining which roads should be maintained based on social and economic criteria. Instead, it is up to the road agencies to determine how best to utilise available funding for maintenance with the overall objective of protecting the physical assets created through the heavy investments made at the time when the roads were constructed.

### Maintaining a commitment

A common misconception when allocating scarce funds for maintenance, is the need to carry out a second prioritisation using indicators such as the importance of the road in the network, size of communities served, traffic volume, agricultural potential in area served by the individual roads and access to basic social services. Roads built to all-weather standards have already been through a prioritisation process. With the decision to build the road in the first place, political decisions have already been made to provide proper transport access. Providing maintenance is therefore a confirmation of the earlier commitment to establish such services. There is no need to repeat such an exercise when preparing a maintenance programme.

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<sup>8</sup> See Rural Roads Manual, Indian Roads Congress, New Delhi 2002

The challenge arises when important roads have been left to deteriorate. Obviously, the roads providing the only connection to many communities or connecting to markets, health centres and schools should remain high on the priority lists. If they have been left to deteriorate, they should be given priority in the plan budget for rehabilitation works. If such roads are still in a fair condition, the road assets need to be given priority in the annual maintenance programme.

Still, the principles of consistency in funding decisions remain. In recent years, rural road development programmes have introduced clear selection and funding criteria that give priority to such roads in order to maximise social and economic benefits of construction investment in improving roads. These benefits will only materialise through a maintenance programme that continues to maintain these commitments.

### 3.7 A preventive approach

To make best use of available budgets and achieve the highest possible service levels, a key priority when preparing a maintenance programme would ideally be to ensure that available funds are used in a preventive rather than in a reactive manner. This obviously implies that available budgets are sufficient to cover both preventive and emergency works.

Timely action should be taken before major damages occur and the roads break down becoming impassable. Even better, action should be taken while damages are still minor, thereby halting the deterioration process at an early stage and thereby also maintaining high service levels for the users. Timely action before major damages occur is less costly to carry out.

In general the old adage that “if it is not broken don’t mend it” could be slightly amended for the common attitude to rural roads into “if it is not broken don’t maintain it”.

The economic benefits of a preventive approach are therefore three-fold. First of all, it lowers total maintenance costs since the defects are attended to before any serious damage takes place. Secondly, the transport user costs remain low since the road is kept in a good condition

at all times, and thirdly it improves the regularity (and reliability) of the service provided by the road.

In order to organise a maintenance programme using a preventive approach, implies that first priority is given to the roads still in good condition. The basic principle here is to avoid such roads at any time falling into serious disrepair by providing adequate and timely routine maintenance.

When maintenance funding is limited, this also implies that some hard decisions need to be taken by the technical staff in charge. Rather than embarking on costly repair works on roads in a poor condition, the available budgets are used for protecting infrastructure assets that are still in a good condition. Such priorities form the basis for a sound asset management system.



### 3.8 Asset management

Financing is often a binding constraint on securing the sustainability of infrastructure investments. The very notion of 'rehabilitation' is often indicative of failed maintenance practices, i.e. the construct - lack of maintenance - deteriorate cycle has taken place at least once (except when a road has reached the end of its design life). In order to avoid such scenarios, sound road management strategies should be adopted to give priority to the conservation of the inherent asset value of existing road infrastructure.

A road network has a certain value that can be estimated in monetary terms. Investments in rehabilitation and improvement works increase the value of roads. On the other hand, road deterioration due to lack of maintenance decreases the value of the network. Road

Fig 3.5: Measuring damage to road assets

agencies aim to increase the total value, thereby maximising the extent and quality of road access being provided. Available budgets therefore need to be carefully balanced between the demand for maintenance and the desire to build new roads (including the rehabilitation of roads in poor condition). Since construction works are much more costly than maintenance, the best approach is always to give high priority to protect existing infrastructure assets.

When designing a road asset management programme, this concept is translated into the following ground rules:

- (i) First, prepare an inventory of various assets viz pavement, embankment, drains, drainage structures, road signs, traffic control devices, protective works for the rural roads under jurisdiction of each Executive Engineer and consolidating for the state.
- (ii) Provide routine maintenance to the infrastructure in a good and maintainable condition. "Good" condition is regarded as when it requires a minimum of routine maintenance, consisting of preventive works measures most of which can be carried out utilising local labour, tools and materials.
- (iii) Then provide spot improvements and periodic maintenance to halt the deterioration of sections in fair condition, thereby reinstating them to a maintainable condition.
- (iv) Rehabilitate existing assets that have fallen into serious disrepair.
- (v) Control and prevent encroachment on the Right-of-way.

From the above, it is clear that effective asset management requires a certain knowledge of the road network. Individual roads need to be assessed and classified according to their condition. Condition assessments of the network are carried out for several purposes and to varying degrees of detail. For rural roads, it is sufficient to determine whether the roads are in good, fair or poor condition as shown in the figure below. On this basis, it is possible to establish a reasonably good picture of the budget requirements for routine and periodic maintenance works as well as rehabilitation and reconstruction works.

	Good	Fair	Poor
current situation	Pavement and drainage system in good order only requiring timely preventive maintenance	Pavement and drainage system still exists but in urgent need of overdue maintenance	No remaining drainage system. Pavement non-existent or in total disrepair, tracks and trails
History	New road or road provided with adequate and timely maintenance	Recently improved road with inadequate maintenance	Never an engineered road or very long absence of any maintenance

A road classified as in good condition would normally require only routine maintenance in order to protect its integrity. Fair condition roads are normally due for more extensive maintenance works. This may be caused by lack of attention to routine maintenance in the past leading to an accelerated deterioration or the road surface has worn off justifying periodic maintenance, thereby re-instating the road to a good condition. Roads in a poor condition mean that they have deteriorated to the extent that most maintenance inputs have limited effect on the quality of the road. This category also includes tracks and trails which were never upgraded to a fully engineered road.

With this broad classification of the road network, it is possible to establish a rough estimate of the total maintenance requirements. The total length of roads in good and fair condition indicate the amount of routine and periodic maintenance. Using average cost estimates for routine and periodic maintenance, it is then possible to prepare budgets with sufficient accuracy. Equally, the number of roads in poor condition forms the basis for preparing an investment programme consisting of improvement and new construction works.

A condition assessment using these broad categories also allows management to monitor the total asset value of the road network over

time. Condition surveys are carried out on a regular basis to plan future road works. As a result, technical staff in charge of a cluster of roads possesses the necessary information to make this assessment of the network. Compiled into a central database, the overall condition of the road network can then be compared to earlier years in order to monitor the extent to which road funding policies result in an improved condition of the network.

Equally important, this exercise is useful as a means to simulate the effect of various funding strategies. An integral part of the process of preparing a road works programme and budget is to look ahead and assess the effect of the investments proposed. As part of the process, it would be logical to make a prediction of the subsequent road condition resulting from the planned maintenance and construction works.

#### **Road asset management in Himachal Pradesh**

The priorities applied in road maintenance in Himachal Pradesh clearly demonstrate a healthy approach to asset management based on the condition of the roads. The Public Works Department carries out regular condition surveys of the road network as part of its annual programming and budget exercise.

First priority is given to allocating sufficient budgets for routine maintenance of all roads in good condition. Secondly, periodic maintenance is provided on the roads in fair condition, where the lifetime of pavements and other road elements have been depleted, i.e. resurfacing works, strengthening pavements, major repairs to drainage structures.

Roads in poor condition are not included in the maintenance programme but instead placed in the capital investment programme for reconstruction or improvement works.

The clear distinction between maintenance and investment activities (non-plan and plan budgets) is not only important in terms of ring-fencing maintenance budgets for its intended purpose. It also clearly identifies the part of the network that should be included in the investment programme.

This exercise can be carried out to various degrees of accuracy. The preferred development is obviously to see the portion of good condition roads increasing while the portion of fair and bad condition roads is reduced. A more precise method is to apply average asset values to good,

fair and poor condition roads. This approach allows planners to monitor the total depreciation or appreciation of the value of the road assets over time. It can also be used to assess the resulting asset value change resulting from combined inputs of maintenance and construction works.

The major challenge with this system is not only to secure adequate funding for routine maintenance work but also to make sure that available budgets are used for this purpose on priority and not diverted to other road works activities.

The real funding challenge is related to securing sufficient budgets for periodic maintenance. The various components of the road are built to last for a certain duration of time. Periodic inputs of maintenance reinstate these road components to desired service levels. Again, the scheduling of such inputs are based on an assessment of optimal timing, (i) before the defects cause serious damage and (ii) when service levels deteriorate below the standards expected by the road users.

### **3.9 Economic analysis**

The principal objectives of road maintenance are to keep roads open, reduce rates of deterioration and extend the life of the road network, reduce vehicle operating costs and improve the speed, frequency, safety and convenience of private and public transport. Maintenance also provides employment opportunities and additional market prospects for the local construction industry. These are the benefits of maintenance, which will be benefits foregone if no maintenance takes place.

The provision of rural roads should be treated as a social service similar to the provision of local schools and health clinics. This is clearly reflected in the basic criteria of the PMGSY in which the overall aim is to provide all-weather road connectivity to most of the rural population thereby facilitating both economic and social development. Therefore, once a rural road has been constructed and/or brought to a maintainable condition, there is no need for an economic analysis to justify maintenance. There is enough all-round evidence and experience that lack of maintenance results in huge cost burden in rehabilitation later.





Fig 3.6: Rural road in need of off-carriageway routine maintenance

### 3.10 Routine maintenance priority

Routine maintenance can be shown to be the most cost effective activity in terms of the upkeep of a road network (along with emergency works). Its benefit to cost ratio is normally far higher than for new construction or for that sake periodic maintenance. For most rural roads, the annual costs of routine maintenance amounts to less than 4 percent of the construction of the road in the first place and around 5 to 10 percent of periodic maintenance costs.

Routine maintenance can be compared to patching a roof before the water leak causes further damage to the roof structure and thereby avoiding expensive works such as replacing larger parts of the building. Failure to provide routine maintenance speeds up the deterioration of the road, necessitating earlier periodic maintenance works, which is more costly. In turn, when both types of maintenance are not secured in time, total rehabilitation works are required at an earlier stage. On the other hand, if preventive routine maintenance is carried out in time, future periodic works can be deferred.

At a certain point of time, routine maintenance becomes less effective and there is a strong justification for more substantial periodic

maintenance works. If there is limited fund available for periodic maintenance, experience shows that the continuation of routine maintenance still has a value. Good drainage and regular inputs of surface maintenance will continue to limit water from causing major damages to the pavement. Although the surface smoothness and user comfort is reduced, the road remains in a functioning condition providing basic access to the rural communities it was intended to serve. Again, this proves the importance of routine maintenance.

Unfortunately, the current practice in many places is that periodic maintenance or major rehabilitation works are given priority instead of first ensuring that routine maintenance is provided to the entire maintainable network.

#### **Current routine maintenance practices**

Recent surveys by the ILO in seven states in Northern India revealed considerable variations in terms of providing regular routine maintenance. Two of the states did not carry out any routine maintenance on rural roads (only renewal works). In four states the maintenance was generally limited to patching works. Only in one state, where the majority of maintenance works is still carried out using departmental labour, did the maintenance arrangements include regular repairs of the drainage system.

### **3.11 Cost of maintenance**

The costs of rural road maintenance depend on a number of factors and for this reason show wide variations. Essentially, maintenance costs are dictated by the cost of the various work activities, i.e. equipment, labour and materials, and the frequency of repairs required. The cost of the maintenance works as well as the amount of damages on a rural road essentially depends on where the road is located and its history of past construction and maintenance works.

Other important factors determining the need for maintenance include the technical design and quality to which the road was originally built, soil conditions, traffic volumes and weather conditions. Rural roads normally receive limited volumes of traffic and therefore variations in

traffic have less impact as compared to rainfall and the type of terrain in which the road is located.

## Type of terrain

Roads through mountainous terrain are always costlier to maintain as compared to roads in flat or gently rolling terrain. The choice of road alignment when the road was built can have a significant impact on the maintenance costs and in particular in mountainous terrain. Road sections with steep longitudinal gradients are more difficult to maintain due to increased risks of soil erosion from surface water.



Fig 3.7: Retaining wall on a PMGSY road in Himachal Pradesh

Large side cuts and fills may also lead to increased maintenance as compared to roads with alignment carefully adjusted to the topography. For this reason, it is important to bear in mind future maintenance challenges when designing the alignment for rural roads.

Roads passing through flood prone terrain pose particular maintenance challenges. In such areas, it is important that there is sufficient cross road drainage and that the pavement is on sufficiently high embankments to keep it dry during high water levels.

## Quality of construction

The quality to which the road was built has a significant impact on ensuing maintenance costs. A well-designed drainage system has a significant impact in terms of reducing future maintenance costs. Lined side drains and frequent use of mitre drains reduces the risk of erosion and silting of the drainage system.

The chosen pavement design determines when strengthening and resurfacing works will be required. Equally, the use of quality building materials obviously has an impact of the longevity of the road.

Aggregate consisting of good angular rock as compared to rounded river gravel increases the strength of pavements. Adequate compaction ensures that pavements reach their intended levels of performance, providing a firm basis for the surface seal.

In mountainous terrain, good design of retaining walls can reduce future maintenance demands. Similarly, frequent culverts with well-designed inlets and outlets with adequate anti-erosion measures will limit future maintenance requirements.



Fig 3.8: Good angular stone aggregate

## Past maintenance

The history of past maintenance on a road has a great impact on the cost of maintenance works. Roads on which limited maintenance have been provided in the past will obviously have a considerable backlog of work which needs to be dealt with. Sadly, good maintenance practices are less common on rural roads as compared to the main road network. When introducing new maintenance practices, the experience is often that the costs of the works are higher than prevailing average cost norms during the initial two to three years. Not only is there a backlog of routine maintenance, there are also many roads which are overdue for periodic maintenance (renewal works).



Fig 3.9: Catching up with long overdue maintenance

Still, it is important that these extra burdens are addressed as soon as possible. Just by reinstating drainage systems and sealing cracks and potholes have a tremendous impact on the longevity of the road as well as providing a significant improvement in the comfort for the users and reduction in transport costs.

The cost of maintenance also varies from year to year on roads being provided regular attention. New roads built to good quality standards normally have limited demands for maintenance during the first years of operation. Equally, roads that have recently been provided periodic maintenance require limited surface maintenance during the next couple of years (there is still a need for off-carriageway maintenance). Finally, when the strength of pavements no longer cater for the prevailing traffic volumes, the need for maintenance will increase.

### **Backlogs of routine maintenance**

In Meghalaya, the ILO recently carried out condition surveys of rural roads - where limited maintenance has been provided in the past. With very limited maintenance provided to rural roads in the past, the main purpose of these surveys was to introduce appropriate methods for surveying the condition of the roads as part of the preparatory activities for letting contracts in which the main emphasis would be to re-instate the drainage system.

With significant maintenance backlogs on all of these roads, it was estimated that off-road carriageway maintenance would amount to an average of Rs.33,000 /km.

## Cost norms

The IRC Rural Roads Manual provides cost norms for routine and periodic maintenance of rural roads.<sup>9</sup> These norms are presented both as average costs per kilometre as well as cost of various maintenance activities. The Rural Roads Manual provides an annual cost norm for routine maintenance (ordinary repairs) ranging between Rs. 22,000 and 88,000 per kilometre. In addition, the responsible technical agencies at state level also maintain cost norms on common routine maintenance activities. These norms need review in the light of actual ground requirements depending upon type of road surface, climate and terrain as also traffic.

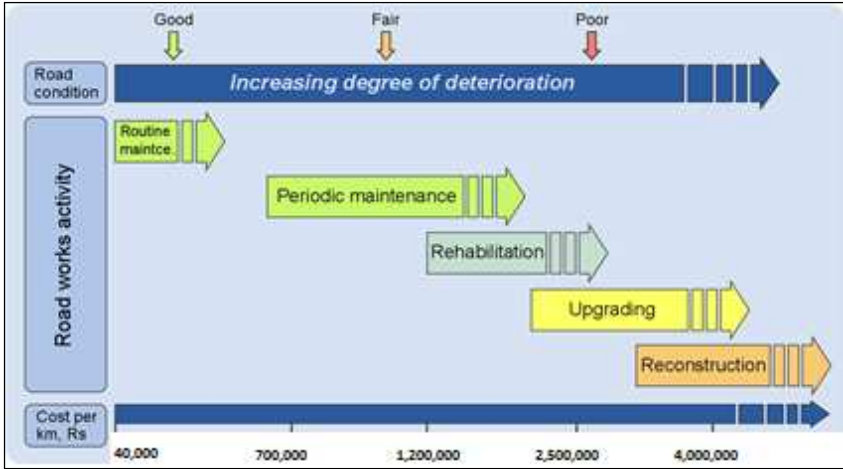
Road agencies therefore need to establish their cost norms based on prevailing prices on construction works and the actual need for maintenance on the roads in each of their districts or divisions. The actual need for maintenance can only be established through regular monitoring of the network and detailed condition surveying. Such cost data provides far more accurate estimates of future budgets necessary to maintain their rural roads.

The figure below provides some indications of cost levels of various types of rural road works. As shown, the cost of road works show considerable variations, again, the main reasons being differences in site conditions, costs of materials and other inputs, and the standards to which the roads are built.

It is clear from this figure that rehabilitation, upgrading and reconstruction works are considerably more costly than maintenance works. This in itself provides a strong argument for providing regular maintenance, thereby avoiding a situation in which costlier activities such as rehabilitation and reconstruction works are required.

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<sup>9</sup> These cost norms are based on the Report of Committee for Norms on Maintenance by the Ministry of Road Transport and Highways



There is a further cost element which is worth noting in this context and that is the very low costs of off-carriage way maintenance works, essentially consisting of keeping the drainage system in a good condition.

The table below presents the costs of such maintenance activities based on 2014 market prices recently used in an estimating exercise in Rajasthan.

Unit prices for routine off-carriageway works		
Activity	Unit	Rate (Rs)
Bush clearing	m <sup>2</sup>	2
Clear side drains (50% silted)	m	18
Clear side drains (100% silted)	m	35
Lower berms	m <sup>2</sup>	18
Repair shoulders	m	15
Side slope repair	m	18
Clear culverts	m <sup>3</sup>	295
Clear culvert inlets/outlets	m <sup>3</sup>	177

The point to be made here is that not only are these simple work activities easily carried out by unskilled labour - they are inexpensive to implement. On the other hand they are probably the most important maintenance activities in terms of protecting a road and slowing down the rate of deterioration. Still, with all these solid arguments, routine maintenance is still not performed on rural roads in many states in a structured manner and including all the required activities.

Obviously it is not a technical issue, nor a funding issue. As in many other countries, it is a management issue and involves setting clear priorities as part of a well-defined policy framework and on that basis introducing effective implementation strategies.

### **Rural road standards**

A common challenge with rural road maintenance is that such roads are often built to varying quality standards. Many local roads are not developed to fully engineered standards. Originally, these roads started out as trails and tracks that have gradually been upgraded to cater for vehicle traffic. Local roads pose particular maintenance challenges, as they often do not have a complete drainage system and adequate road pavements.

In this respect, the PMGSY has had a tremendous effect in terms of lifting rural road standards through the uniform application of adequate designs and quality. Furthermore, the good performance of PMGSY roads indicate that the standard designs applied generally cater well for the type of traffic normally found on local roads. It is now recognised that these design standards perform well and for this reason several states have embarked on upgrading local roads built to the same standards.

The solid designs used in the PMGSY seem to result in low maintenance costs. In most places, the pavements perform well after more than 10 years of use, only requiring minor surface repairs.



## 4 Technical considerations

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### 4.1 General

Rural road maintenance is not a new topic. This type of works has been carried out since the Romans built their road network some 2000 years ago. Equally, in the 21st century we are in a position to implement such works applying the most appropriate technology for this purpose. The evidence for this is clear from the works carried out where rural roads remain passable despite the wear and tear caused by traffic and the environment.



Fig 4.1: Local traffic in Assam

Since road agencies have the capacity to construct roads, the technical capacity to maintain the roads should be available in the ensuing stage. The technology as such, relating to the individual work activities, is not much different from those required to construct and rehabilitate roads. Such work is well documented in manuals and work specifications. Appropriate work methods and productivity rates have been established for this type of works in equal level of detail as for construction works. The management requirements are well known and effective procedures have been developed for implementation of rural road maintenance.

Without compromising the importance of maintenance, it is generally accepted that the technology required is simple and easy to apply.

Experience also shows that the technology and work methods can easily be disseminated to local contractors and government staff.

## 4.2 Functional requirements of rural roads

The main function of rural roads is to provide access. As such, rural roads have a distinctly different function from the main arteries of a road network. While highways are designed to cater for high levels of traffic, travelling longer distances at higher speeds, the main purpose of rural roads is to provide a reliable connection throughout the year between local communities and the main arteries in the road network. Since traffic volumes are low and the fact that local roads are shorter, there is no demand for very high design standards on this part of the network. However, they need to be well engineered.

Since rural roads cover large geographical areas in order to provide access to all communities, there is a need for an extensive network. As a result rural roads constitute some 80 percent of the total length of the road network.

When constructing these roads, there is therefore a need to select affordable design solutions that meet its functional requirements of providing basic access throughout the year. Equally important is the need to arrive at technically sound



Fig 4.2: PMGSY providing basic all-weather

designs that keeps the future maintenance costs at a minimum.

### **Definition**

An all-weather road has been defined by the Indian Roads Congress as a road, which is negotiable during all weathers, except at major river crossings. This implies that the roadbed is drained effectively by adequate cross drainage structures, such as culverts, minor bridges and causeways. Interruption to traffic as per permitted frequency and duration are however allowed. The pavement should be negotiable during all weathers, but this does not necessarily imply that it should be paved or surfaced or black-topped. An earthen road with gravelly soil or an earthen road with a gravel or WBM layer on top permits all-weather use, depending upon rainfall and soil type.

### **Alignment choice**

The choice of alignment has a major impact on future maintenance requirements. High alignment standards, aiming to increase curve radii and reducing road gradients, require more earth cuts and fills which may lead to an increase of soil erosion. By lowering the design speeds, the road curvature can be fitted gently into the existing terrain thereby reducing the amount of excavation works and limiting future maintenance demands.

### **Cross-sections**

To limit construction and future maintenance costs, the width of rural roads is kept at minimum dimensions that still allow sufficient space for the traffic to operate. The current IRC standards are applied to PMGSY and the states may apply the same standards for the non-PMGSY roads as well.

### **Axle loads**

An important role of rural roads is to facilitate the transport of agricultural produce from farm to market. The transport is normally organised through the use of trucks. Such traffic requires properly engineered roads with adequate consideration given to the pavement design and cross-drainage structures. The pavement and cross-drainage structures need to cater for the same axle loads as the rest of the network. The standard pavement designs used in the PMGSY cater for the

prevalent traffic and as a result limited damage is observed on the pavement.

## Surface

Most rural roads are either earth roads or provided with a gravel surface, which is often adequate on roads with very limited traffic. The most important components of such roads are those related to drainage, since the main wear and tear is caused by rainfall. Where traffic numbers are higher, it is necessary to consider more durable pavements including a bituminous surface seal. Bituminous seals provide a more durable surface which is less prone to erosion from traffic and surface water. Both at the time of original construction and while undertaking periodic maintenance of road surface, the requirement of skid resistance should also be considered to reduce risk of aquaplaning which is a safety hazard.

The longevity of any surface seal is mainly dependent on the quality of (i) the underlying pavement and (ii) the drainage of the surface. A solid base course provides adequate support to the surface seal allowing heavy vehicles to pass without causing any damage. A well maintained camber or cross-fall on the road carriageway and its shoulders allows water to quickly drain off the road. Poor surface drainage resulting in stagnant water on the road or its shoulders will eventually penetrate into the road body and compromise its load bearing capacity. Heavy vehicles passing on a soft road foundation will cause depressions which in turn may lead to the surface cracking up.



Fig 4.3: Progression to Pot-Hole

## Roughness indicators

Since rural roads are designed to cater for lower design speeds than highways, there is not the same demand for a low roughness of the surface as compared to main roads where traffic travel at higher speeds. Although the construction of the surface should conform to established workmanship standards, the development of a higher roughness on rural roads is not as critical as on highways. The main concern related to the quality of the surface on rural roads is to avoid water penetration into the road body, which may compromise the bearing capacity of the pavement. Due to the lower prevailing speed on these roads, the development of a higher surface roughness can be tolerated as long as the surface maintains its drainage. In practice, this implies that the amount of patching works can be increased before there is a need to provide a complete new surface seal.



Fig 4.4: Excavating side drains, Meghalaya

## Drainage

A key design parameter determining future maintenance requirements is the drainage system. The drainage system needs to cater for intensity of rains, evacuating surface water in a controlled manner without causing

erosion or silting of road components or surrounding areas. Equally, the drainage system needs structures for streams and rivers crossing the road alignment. The cross drainage structures are designed for peak flows during the rainy season to avoid causing any damage to the road. Investing in proper drainage is therefore an important preventive measure to limit future maintenance demands.

## Road safety

Road maintenance works essentially aim to preserve the design and quality standards applied when the road was built. This principle also extends to the safety measures installed as part of the road design. This implies that signage and line markings, speed regulating and other measures need to be given due attention also during planning and implementation of maintenance works. Traffic increases and higher driving speeds resulting from improved roads can also cause new traffic hazards. Therefore, it is useful to include the rural road network in on-going traffic safety monitoring schemes to identify black-spots and high-risk zones. Rural roads are often where local communities, including children are most exposed to road traffic. Although adequate traffic safety measures should be installed during the construction of the road, experience clearly shows that more can be done during the operation of the network. Some road safety concerns can be dealt with through interventions such as additional signage and speed regulating measures. Very often, such measures are simple and inexpensive to install and can be included in on-going maintenance programmes.

### 4.3 Design standards

Like any other road, rural roads are designed and maintained for specific levels of serviceability and vehicle types, taking into consideration local terrain conditions and weather patterns. Rural road designs focus on reliability and durability concentrating on essential access, careful attention to critical sections (poor sub-soils, gradients, flood patterns, landslides, etc.), surface drainage and installing long-lasting cross-drainage structures.

The technical standards for rural roads in India have been developed on the basis of extensive experience from earlier works and prevailing traffic patterns. The most common design for the construction of all-weather rural roads consists of a flexible pavement on an earthwork formation with a granular sub-base, water-bound Macadam (WBM) base course and suitable surface course. The type of surface is decided based on the intensity of motorised traffic and annual rainfall. The surface may range from an unsealed surface (gravel road) to a bituminous surface with a pre-mixed carpet and seal coat.



The experience from this design is that the majority of roads built to such standards (such as by the PMGSY programme) perform well. The pavement designs used generally cater for the traffic loads experienced on these roads.<sup>10</sup> A positive feature from this practice is that there is very little settlements observed on the roads built to these standards. In terms of maintenance, this implies that the majority of repairs required on the pavement are related to the surface seal business off-carriageway maintenance activities.

Current rural road standards prescribe modest geometric designs for cross sections and road alignments thereby reducing the need for excessive earthworks. This leaves a smaller environmental footprint and in turn has a positive impact on demands for maintenance.

Equally, careful attention is given to the design of the drainage system. The practice of building lined drains limits silting and scouring from

<sup>10</sup> Most of these roads are providing basic access to rural communities with limited traffic levels. Although this is the general trend, it is acknowledged that some roads are experiencing increased levels of traffic justifying upgrading works applying higher cross-section standards.

taking place. Furthermore, adequate and quality cross-drainage allows for a safe discharge of water away from the road.

### Dealing with excessive traffic

When establishing new connectivity in rural areas, it is often difficult to predict the resulting traffic once construction works have been completed. Still, experience shows that average daily traffic on most rural roads is in the range of 20 to 200 vehicles per day, although traffic numbers may be higher in more densely populated areas. For this reason, most rural roads can be built applying a uniform standard that caters for low volumes of traffic but still stands up to the prevailing weather conditions.

There are however instances when local loads experience high volumes of traffic and also excessive amounts of heavy vehicles. At times, rural roads may provide shorter travelling distances and thereby attract more traffic. Equally, mining operations or collection points for agricultural produce may cause increased volume of heavy traffic.

Increased traffic volumes may dictate higher design standards than to which the road was originally built. If this is not done, there is a risk that maintenance works become ineffective due to the inconsistency between the road design and traffic loads.

A lot can be done by strengthening the pavement to cater for an increase in traffic, and is probably the most common solution. However, with more traffic, there may also be a need for pavement widening, a more durable surface treatment and an increased road width to allow safe passage of the traffic.

Considering the uncertainty involved in predicting future traffic when building new roads, it is therefore useful to have a clear strategy for stage construction in the cases where traffic increases to unexpected levels rather than overburdening the maintenance programme.

The quality to which the road was originally built has a great impact on the need for ensuing maintenance. Quality assurance measures during the construction of the road need to ensure that good workmanship is secured and that materials are to the prescribed quality. Again, there are good lessons learnt from the PMGSY with the quality control system it has instituted. Roads built under the PMGSY are of good quality, which in turn limits the need for costly repairs when a maintenance regime is applied to these roads.



Having developed sound rural road standards, the main challenge at present is not so much related to current rural road building practices, but rather addressing the extensive networks of rural roads built in the past which do not conform to such standards. These roads require more resources to maintain and in many cases due to their poor condition should receive upgradation works.

## 4.4 Drainage

### General

In terms of securing a long life for rural roads, the most important type of maintenance is related to protecting the drainage system - most of which is found outside the carriageway. On highways, where traffic volumes are more intense, a substantial amount of resources are also used to maintain the roadway surface. Compared to highways, rural roads receive low levels of traffic and pavement works constitute a smaller proportion of the maintenance required. For these roads, the maintenance priorities are more linked to the provision and upkeep of the drainage system.

Water is the main culprit behind defects developing on the carriageway or the roadside. It is the main contributor to the wear and damage of low-volume rural roads. A central part of road maintenance works is to direct water away from the road structure as quickly and efficiently as possible. With a well-built road, the most crucial element of maintenance works consists of ensuring that the drainage system continues to operate effectively.

Water can be in the form of ground water, surface water (streams and rivers) or rain and can damage the road in several ways:

- ✓ by washing away soils (erosion and scouring),
- ✓ weakening the load bearing capacity of the road pavement,
- ✓ by depositing soils (silting) that obstruct the passage of water, or
- ✓ by washing away entire stretch of the road and its structures.

Damage and wear to the road can be reduced if the flow of water is controlled. Minor damages can easily be repaired as part of the regular maintenance provided to the road and its structures. If the flow of water is not properly managed, the deterioration of the road will be more serious and occur more rapidly. This leads to higher maintenance demands and in the worst cases result in serious damages that may obstruct the passage of traffic.

The drainage system is built up as a continuous network from where the water reaches the road reserve to the point where it is discharged in a safe manner away from the road and all its components. A failure at any point in this system runs the risk of causing damage to the road. When inspecting the drainage system, it is therefore important to verify that the entire system is in good order.

A common denominator for an effective drainage system is to keep it free from all obstructions, such as rocks, branches, silt and other debris. The most common activities consist of clearing shoulders, drains and culverts. In addition, it is important to carry out preventive action at the source of the debris. Installing adequate anti-erosion measures avoids any scouring or silting in drains, side slopes and waterways.

Finally, it is also worth mentioning that the drainage system may have an impact on the environment in the vicinity of the road. Water collected through a road drainage system needs to be carefully discharged, avoiding any damages to the adjacent land and properties. Equally, the drainage system needs to be carefully adjusted so it does not conflict with the drainage systems on adjacent farmlands.

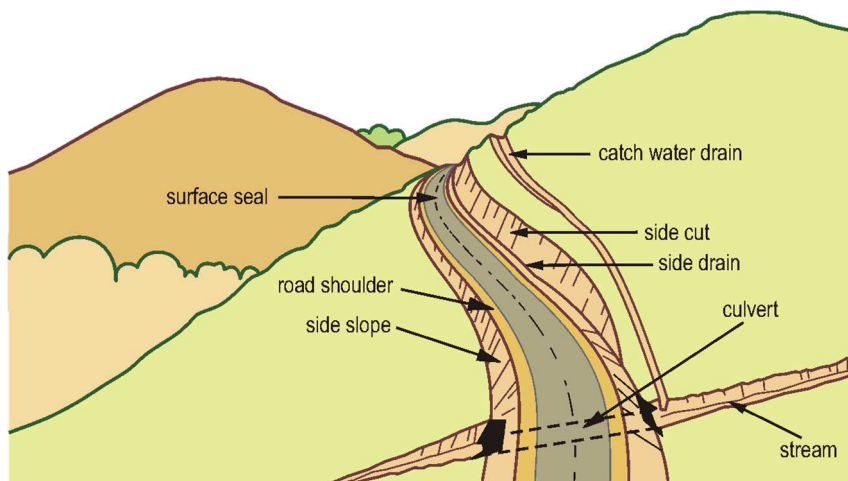
Roads are often constructed during the period when there is limited rainfall. It is therefore only during the ensuing rainy seasons, it is possible to establish whether the design of the drainage system is adequate and sufficient anti-erosion measures have been installed.

When carrying out drainage maintenance, it is important that the reasons for the damages are fully understood. When surveying, it is essential to establish the exact cause and effect of any drainage failures. The performance of the drainage system should therefore be observed during rainy periods, in order to obtain a realistic impression of the how, and how much, water is moving in the vicinity of the road. On this basis, good preventive measures can be taken that hopefully reduce future maintenance requirements - and increase the lifetime of the road.

### Surface drainage

Drainage of the road surface is provided by shaping the carriageway with a camber or a cross slope. The combination of stagnant water on the road surface and traffic can quickly cause erosion of the road surface. Secondly, if surface water penetrates into the road body, it reduces the load bearing capacity of the pavement, which may cause further damage to the road. To avoid these problems, it is important to secure adequate drainage of the road surface.

Most roads are designed with a camber with its highest point at the road centre line, with a descending gradient towards the road shoulders. On



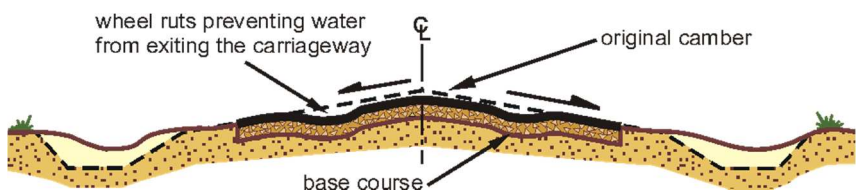
narrow local roads, the camber may be constructed with a cross-slope providing a continuous slope from one side of the road to the other.

Cross-slopes are also used to achieve good driving dynamics to counter the centrifugal forces exerted on a vehicle manoeuvring a curve. When roads have a grade towards the cut side of a slope, the surface water is led away to a side drain and eventually through some form of crossroad drainage arrangement such as a culvert or a splash.

The optimal gradient of this slope varies depending on the type of surface materials. For earth and gravel roads, it is recommended that the camber is installed with a slope in the range of 7 - 8 percent. On earth roads where the surface gets slippery when wet, it may be necessary to reduce the camber slope.

For roads with a bitumen or concrete surface, the camber is normally not more than 2 to 3 percent, because water will easily flow off a hard, waterproof surface. On earth and gravel roads, the camber needs to be steeper because the water flows more slowly and the surface is often more uneven. Gravel and earth surfaces also absorb some of the surface water unless it is quickly drained away from the road.

Maintaining the road surface is a common maintenance activity. A smooth road surface is the key quality criteria for the road users. From a technical point of view, it is important to maintain a tight and self-draining seal on the roadway in order to protect the underlying pavement layers. Water penetrating into the base course and sub base may compromise the load bearing capacity.

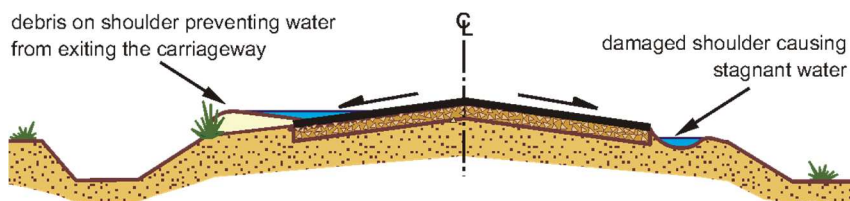


Securing a long-lasting camber very much depends on the design and quality of the initial construction works. It is of particular importance that the base course has been designed and built to a strength and quality catering for the prevailing traffic. Overloading and excessive traffic can cause damage to the surface and reduce the camber slope.

### Trimming road shoulders

The road shoulders need to be maintained to their original shape and slope to allow for water to be drained off the road surface. Standing water at the edge of the road softens the shoulders and also causes water to penetrate the road pavement, resulting in loss of bearing capacity of the shoulders and the road carriageway.

Silt and debris have a tendency to accumulate on the road shoulders. This accumulation of soil needs to be removed, thereby reinstating the correct slope on the shoulders in order to secure proper drainage of the road surface.

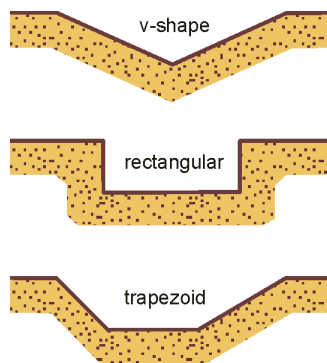


Rural roads are often built with soft shoulders, i.e. the materials used for constructing the shoulders are not as strong as the pavement. Traffic may create wheel ruts on the shoulders, which in turn may trigger potholes and edge breaks on the road pavement. Regular maintenance of the shoulders will reduce these problems.

Maintaining a grass cover protects the shoulders from scouring and traffic. On narrow roads with moderate traffic, the best solution is to extend the base course to the edge of the road, thereby providing a more solid surface at places where the traffic makes frequent use of the shoulders. Alternatively, sections with weak shoulders can be patched with well-graded gravel material.

## Side drains

Side drains collect water from the carriageway and surrounding areas and lead it to an exit point where it can be safely discharged. The side drains need sufficient capacity to collect all rainwater from the road carriageway and dispose of it quickly and in a controlled manner to minimise damage. Side drains can be constructed in three forms: V-shaped, rectangular or as a trapezoid.



The V-shape is the standard shape for ditches constructed by a motor-grader. It can be easily maintained by heavy equipment. However, it carries a lower capacity than other cross-section shapes. The rectangular shape requires less space but needs to be lined with rock or concrete to maintain its shape. This shape is often used in urban areas where there is limited space.

Trapezoid shaped side drains are built and maintained using manual labour. This shape carries a high flow capacity and by carefully selecting the right gradients for its side slopes, will resist erosion. Trapezoid drains can also be lined, thereby increasing their flow capacity and resistance to scouring. Lined drains do however need to be cleared of silt and debris using manual labour.



Fig 4.6: The lack of maintenance of road shoulders has resulted in poor drainage of the surface leading to premature failure of the surface seal.

The main challenge in terms of maintaining good quality side drains is to control erosion and silting. Erosion is caused by large quantities of water travelling at high speeds. Soil erosion can be reduced by various design measures such as widening the side drains, installing scour checks, lining the side drains and by leading the water away from the road before it builds up a significant flow and speed.



Fig 4.7: Silt accumulating in side drain

In hilly areas, side drains need closer attention due to rock fall and landslides. These soils and debris usually end up in the side drains and need to be cleared as soon as possible before the water finds alternative routes outside the drain.

Clearing side drains is usually carried out using manual labour. The table below shows some appropriate task rates for such work. It is useful is to convert these rates using linear metres of drains, on the basis of the depth of soils to be removed and the original cross section dimensions of the drain.

Soil condition			tasks based on ditches without any standing water
moist and loose	average	hard and dry soil	
4.5 m <sup>3</sup> /wd	4.0 m <sup>3</sup> /wd	3.5 m <sup>3</sup> /wd	

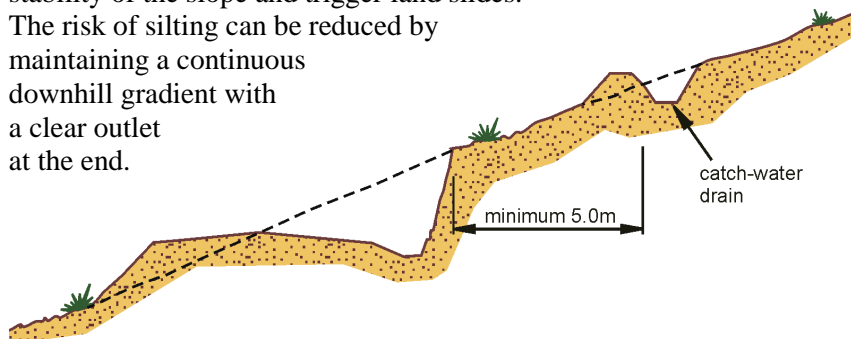
Soils and debris removed from the drains need to be discharged at a safe location where there is no risk of it being washed back into the drains or causing damage to downstream properties.

## Catch-water drains (cut-off drains)

Catch water drains are ditches more or less parallel to the road. Their function is to collect surface water coming from higher lying areas before it reaches the road and divert it to safe crossings such as at culverts, bridges and drifts. These drains are effective in reducing the amount of water reaching the road, thus limiting the potential damage to the road and consequently reducing the maintenance costs.

Catch-water drains usually have a trapezoidal cross-section. The drains need to be easy to maintain thereby limiting erosion damage and maintenance needs (wide with sloped sides). Not properly maintained catch-water drains may start pooling water and reduce the stability of the slope and trigger land slides.

The risk of silting can be reduced by maintaining a continuous downhill gradient with a clear outlet at the end.



Cut-off drains need to be regularly monitored considering the following:

- surface water often carries a lot of silt and if not properly built, the drain can silt up quickly,
- as they are off the road they often receive less maintenance - especially when they are difficult to reach,
- when they fail, water can break through in a concentrated flow causing damage, and
- they may be ploughed up or blocked off by people using the land.



## Culverts

Culverts are the most common cross-drainage structure used on roads. Culverts are required in order to (i) allow natural streams to cross the road, and (ii) discharge surface water from drains and the areas adjacent to the road.

Culverts are constructed using a wide variety of designs. The most common culvert design is based on the use of concrete pipes. Pipe culverts are built with one to three rows of pipes with diameters commonly ranging from 0.6m to 1m. Smaller diameters are discouraged as they have a tendency to block up more frequently and are more difficult to clean.



Fig 4.8: Blocked culvert

Culverts form an essential part of the drainage system, and for this reason need regular maintenance. The most common maintenance activity for culverts is to keep the pipes clear of silt and other debris. As part of this activity, it is important to maintain the inlets and outlets free of silt and other obstructions.



Fig 4.9: Culvert clear of debris

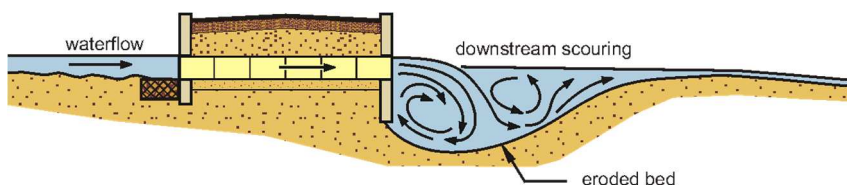
Culverts are maintained using manual labour. When cleaning the pipes, it is useful to have a shovel with an extra-long handle.

The table below shows some appropriate task rates for clearing culvert pipes.

When clearing the pipes, it is important to check the integrity of the pipe joints to verify that the pipes have not been damaged or dislodged.

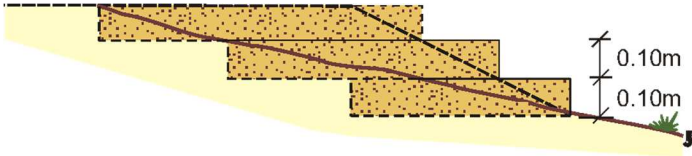
Diameter	Task difficulty: depth of silt in culvert pipes				Tasks relate to culvert pipes with a total length of 6m
	up to ¼	¼ to ½	½ to ¾	over ¾	
600 mm	5 rows/wd	3 rows/wd	1 row/wd	2 wd/row	
1000 mm	2 rows/wd	1 row/wd	2 wd/row	3 wd/row	

Culvert aprons and headwalls need to be inspected for any cracks, damages and settlements. The apron on the downstream side needs particular attention ensuring that there is no scouring taking place. Finally, it is important that the discharge of water from any culvert does not cause any erosion to downstream slopes or properties.



## Side slope stabilisation

Slide slopes are prone to erosion. When rebuilding a side slope, it needs to be carried out preferably using a graded material which is properly compacted. This involves cutting a bench on which new soils are added in layers not thicker than 10 cm and compacted with hand rammers. Make sure there is some moisture in the soils when compacting. Once sufficient layers have been placed, the surface is trimmed to the desired slope gradient and covered with grass to prevent future erosion.



### Grass cutting and bush clearing

Clearing vegetation in the road reserve is important in order to maintain off-carriageway drainage. Removing bush and grass allows for the free flow of water on slopes and in drains. Tall grass and bushes also have a tendency to collect debris, which in turn may compromise the performance of the drainage system. Excessive vegetation along the road also reduces the line of sight for traffic. It also renders shoulders unusable for pedestrians and cyclists.

Clearing works consist of trimming grass, removal of bushes and other vegetation and rubbish in the road reserve. It may also involve trimming of branches of trees when these cause obstructions to the road users or there is a risk that they may break off and obstruct the traffic. Trimmings and removed bush must be disposed of in a safe manner not causing any future damage to the road or nearby properties.

Grass on shoulders, side slopes and in drains should be cut, leaving the roots intact. Healthy growth of grass stabilises soils and provides these surfaces with



Fig 4.10: Need to clear bush in side drains

good protection from soils eroding during extensive rains.

When repairing side slopes it is often useful to plant grass and other types of vegetation as a measure to protect the surface from scouring.

When tree saplings have newly been planted, it is important that they are not damaged when clearing grass and bush around the saplings. Furthermore, vegetation close to these saplings should be removed to allow good growing conditions.

The main growth of grass and bushes take place in the rainy season. For this reason, this activity is normally scheduled to take place immediately before the rains commence and at some point during the rainy period.



Fig 4.11: Vegetation neatly trimmed on shoulders and in drains

Bush clearing is carried out using manual labour. The work can be organised as task work, giving each worker or a group of workers a clearly defined area to clear each day. Contract documents would use square metres as the unit of measurement, however at site it is easier to allocate work by indicating a specific length of the road within which the road reserve is to be cleared. Indicative task outputs are shown in the table below.

Task difficulty - density of vegetation	
Light	Dense
300 m <sup>2</sup> /wd	200 m <sup>2</sup> /wd

Grass cutting is a favourite activity among maintenance workers, however it is not necessarily the most important type of work in a maintenance programme. A common feature is to see maintenance gangs busy with vegetation control while crucial activities such as clearing culvert pipes have been ignored. Although bush clearing is an important routine maintenance activity, it is important that its priority in relation to other work is fully acknowledged.

## 4.5 Pavements

The main concern of users of rural roads is to be able to travel safely and at reasonable comfort at any time of the year. Road users will normally assess the quality of this service based on the condition of the road surface.

Technical staff, involved in preserving the road network however, needs to monitor the condition of all road components, knowing well that for a road to function properly maintenance inputs are required beyond the confines of the carriageway.



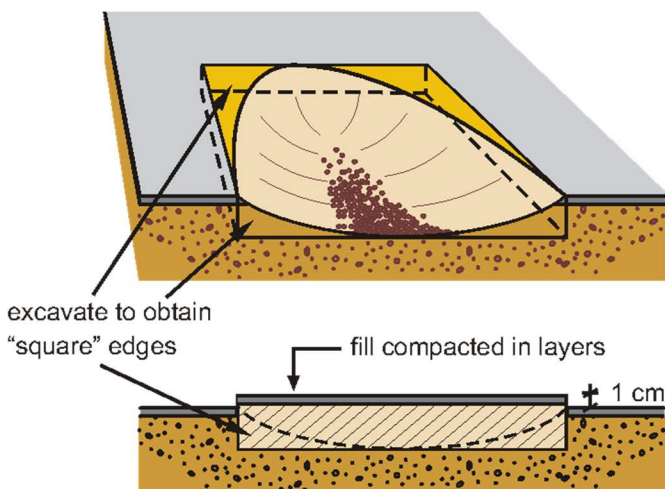
Fig 4.12: Good riding surface on PMGSY road, Rajasthan

Although, the pavement constitutes the most valuable component of a road, its protection is not only a matter of timely repairs focusing on the surface. The longevity of the pavement is also closely linked to the proper operation of the drainage system and ensuring that the road has a pavement and sub-grade with adequate load bearing capacity to cater for the expected traffic.

## Potholes

Potholes are a common form of damage on both paved and unpaved roads. They develop under the action of tyres, especially from heavy vehicles. For roads with a sound base course, they eventually develop when the surface seal is worn out. Potholes may develop earlier from cracks in the surface caused by pavement settlements resulting from inadequate load capacity or unstable fills or sub-grades.

Potholes increase rapidly in size during the rainy season when water collects inside the hole. Besides causing discomfort to the road users, potholes allow water to penetrate into the pavement, thereby compromising its load bearing capacity, which in turn accelerates the deterioration of the pavement and its surface.



Patching should preferably be carried out at an early stage when the damage is still limited to the surface seal while the base course is still intact. In such cases, the remedial works only consist of applying a new seal to the surface.

Deeper potholes penetrating into the base course require more elaborate repairs. This includes cutting back the pothole reaching a sound road base and creating a rectangular shape with clean vertical walls. The base

and side surfaces are then coated with an appropriate bitumen primer before the hole is filled and compacted with quality material similar to the existing base course and finally provided a new surface seal.



Fig 4.13: Poor quality aggregate in base course causing premature potholes

Potholes often develop as a result of poor drainage of the base course. Blocked side drains or culverts, resulting in water penetrating the pavement, may be the reason for such damages. When carrying out patching works it is therefore useful to examine the flow of water on this particular road section and if necessary

take adequate action to secure its safe drainage from the road.

On roads with base courses consisting of Water-Bound Macadam, the reason for potholes can often be traced back to the use of inferior material. If the base was built using rounded aggregates, it will not achieve the necessary cohesive properties required to cater for heavy traffic.

Without the interlocking achieved with angular aggregate, there will be movements in the base course aggregate which breaks up the surface seal. Although this problem can appear on any road, it materialises more quickly on road sections with steep gradients.

The frequent occurrence of potholes can also be an indicator of a poorly performing base course or sub-grade. Although patching works is a relatively inexpensive activity, it may at some point be necessary to consider more costly solutions such as adding a pavement strengthening course.<sup>11</sup>

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<sup>11</sup> Older rural roads built before the launch of the PMGSY were not equipped with the same quality base course. With increasing levels of traffic, many of these roads are now in need of pavement

## Edge repair

Edge failures are caused by weak materials and poor shoulder maintenance that leaves the surface of the road pavement higher than the adjacent shoulder. The unsupported edge then breaks away by traffic, narrowing the running surface of the road.

Edges are often more vulnerable to settlements due to shoulders consisting of poor materials or with poor drainage. Rural roads with narrow carriageways rely on the shoulders for passing traffic. With increasing levels of traffic, the shoulders of such roads should be strengthened, preferably using similar materials as in the base course or a well-graded gravel material. Maintaining a healthy cover of grass on the shoulder will also protect the edges of the surface seal.



Fig 4.14: Edge of pavement breaking

## Ravelling



Fig 4.15: Ravelling

Ravelling is a process in which the surface layer loses its aggregate particles due to insufficient binder in the surface seal. This may take place when there is insufficient bonding with the underlying surface or from an uneven application of binder when applying a chip and spray seal. A poorly maintained spray bar with blocked nozzles or the incorrect

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upgrading. In some states, there is now also a growing demand to upgrade earlier PMGSY roads experiencing excessive traffic growth.



adjustment of the height of the spray bar will produce an uneven application of binder. Equally, incorrect binder content in a surface premix may cause ravelling. Finally, ravelling can take place if the surface seal is poorly spread and compacted. Ravelling reduces the thickness and durability of the surface seal. Areas with severe ravelling require patching or resealing. Left unattended it will result in the formation of potholes.<sup>12</sup>

## Delamination

A delamination is a result of poor bonding with the underlying surface or insufficient stability of the wearing course, resulting in a total loss of the surface seal. The loss of the surface seal may eventually lead to the development of potholes unless the defect is addressed by patching or resealing the failed section.



Fig 4.16: Delamination

## Cracks

Cracks in the road surface can develop in various patterns and frequency. Most cracks are caused by movements or settlements in the underlying pavement layers as a result of poor materials or workmanship, instability of fills and shoulders or movements in the sub-grade. Settlements may also take place on aged pavements or as a result of traffic growth necessitating higher pavement standards.

Individual cracks can be sealed in order to prevent water from entering and weakening the pavement. A high occurrence of cracks (e.g. crocodile cracks) needs to be treated with a new seal. If left unattended, cracks develop into potholes, causing further damage to the pavement and its surface.

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<sup>12</sup> Sample pictures on this page are from the Defects Catalogue Manual in Himachal Pradesh.



Fig 4.17: Large cracks

The frequency of cracks provides some indication of which layer of the pavement is causing the settlement. When there are less frequent cracks, the settlements are likely to originate from the deepest layers in the pavement, i.e. the sub grade or sub-base.

Some settlements may eventually subside and repair work is only required on the surface. Settlement cracks caused by insufficient pavement strength or unstable fills will reappear and can eventually result in a disintegration of the surface. In these cases, more substantial remedial measures are required such as stabilising fills and strengthening the pavement.

## Rutting

Wheel ruts are caused by deformations in pavements with insufficient strength to cater for the prevailing traffic, mostly as a result of poor compaction works or overloaded vehicles. It often takes place on roads with a high prevalence of heavy traffic for which the pavement was not designed.

The longitudinal depressions resulting from rutting compromises the road camber, restricting water from being drained from the road surface. Un-drained water penetrating the surface can further weaken the pavement leading to more deformations and finally breaking the surface.



Fig 4.18: Rutting

Shallow ruts can be treated by filling the depression with an additional seal. More severe rutting, i.e. deeper than 50mm, can be repaired in a similar manner as when patching deep potholes. The wheel ruts are then

cut to a rectangular cross section and filled with base course material and finally sealed.

## Depressions

Localised depressions are caused by the uneven settlement of the pavement layers often for the same reasons as when rutting occurs. Depressions are more common on older roads with limited pavement strengths and which are experiencing heavy traffic. Depressions on new roads are either a result of construction faults, using poor quality materials or when the drainage fails resulting in the pavement being saturated with water. Depressions can also develop as a result of differential movements at structures, often found at bridge and culvert approaches.



Fig 4.19: Depression and resulting cracks

Besides compromising the smoothness of the road surface, depressions lead to severe cracking and eventually the surface breaking up. Being the result of poor load bearing capacity, it is often necessary to replace inferior material in the base course and sub-grade. Frequent depressions on a longer road section can be treated by adding a new strengthening layer.

## Bleeding

Bleeding is a result of excessive amounts of bitumen binder in the surface seal. The excess binder is forced to the road surface by the action of traffic. The spot where bleeding has occurred is soft and has a smooth surface. The “fat” surface reduces skid resistance, especially when wet. In extreme cases, the surface layer may separate and break away under the action of traffic. Repair works normally consist of spreading sand on the soft areas. Large areas of bleeding are treated by applying a new surface dressing.

## 4.6 Timing of works

Having carried out a road condition survey, some of the damages observed require immediate attention while other remedial works can be programmed to take place at a later stage when a batch of maintenance contracts is planned. The table below attempts to prioritise works according to key factors concerned with (i) safe and unobstructed flow of traffic, (ii) preservation of the road assets and (iii) preventive maintenance to avoid any further deterioration.

The highest priority is obviously related to safe and unobstructed flow of traffic. Such activities are given urgent attention. Special attention is given to activities that should not wait from a preservation point of view. This work should be carried out without much delay, thereby limiting the extent of damages and thus preserving the assets. Routine activities can be given less priority and carried out during slack work periods. Equally, recurrent activities are scheduled to take place when other recurrent maintenance is required.

## 4.7 Classifying the condition of the road

An overall assessment of the condition of the road network is useful for long-term planning and budgeting purposes. Keeping updated records of the overall condition of the road network can over time confirm whether the budgets are used in an effective manner which preserves the total asset value of the network.

Whether the road is in good, fair or poor condition indicates what type of interventions is required in order to reach the desired service levels expected by its users. Roads in good or fair condition would be characterised as maintainable roads and are included in the annual maintenance programmes. Although, poor and very poor condition roads may have some assets worth maintaining, they need significant reconstruction or improvement works in order to reach desired service levels. Equally, their poor condition renders most common maintenance activities useless resulting in limited impact since the key functional standards of the road are not in place.

Damage	Criteria	Action	Priority
<b>Features concerned with safety of traffic</b>			
Breaches or blockages in the roadway	Any type of breach, that endangers safety of traffic or obstruct flow of traffic	Remove blockages and repair cuts	Urgent
Tree branches at height less than 4.5m over the roadway		Cut branches in order of lower ones first	Special attention
<b>Carriageway and crust condition</b>			
Cracking without rutting	Cracking in local areas less than 25% of the total area	Local sealing or filling of cracks	Routine
	More than 25% of total area		Special attention
Stripping	Less than 25% of total areas	Apply local sealing	Routine
	Exceeding 25% of total area	Apply surface dressing	Special attention
Bleeding	Less than 25% of total area	Sand the surface	Routine
	Exceeding 25% of total area	Apply surface dressing	Special attention
Rutting	Less than 50mm depth with limited cracking	Prime and fill with bituminous mix	Routine
	Less than 50mm with severe cracking		Special attention
	More than 50mm depth with severe cracking	With surface dressing over cracks Overlay required	Special attention
Potholes	As soon as they develop	Patching	Special attention
Reflection cracks	Widely spaced	Crack Sealing	Recurrent
	Closely spaced	Apply surface dressing	Special attention
Edge subsistence and rutting	Any extent	Patch road edge and repair shoulder	Recurrent
Deficient camber	Any extent	Reconstruct camber	Special attention
Undulations	Any extent	Investigate and rectify	Special attention
Loss of material on unpaved road	Any extent	Regravelling	Special attention
<b>Shoulders and side drains</b>			
Deformation or scouring of shoulders	Any extent	Fill and compact to restore camber	Routine
Silting of side drains	Any extent	Clean the drains	Routine
Scouring in side drains	Any extent	Reconstruct to desired shape. Install scour checks and mitre drains	Special attention
<b>Cross drainage works</b>			
Causeways: Potholes in paved surface, erosion of inlets, outlets and guide posts		Patching, repair and replace	Special attention
Culverts: Silting, erosion of inlets and outlets, and settlement cracks		Remove silt, repair erosion and cracks	Special attention
<b>Other works</b>			
Vegetation control		Remove bush and cut grass	Routine
Road furniture and signs dirty, corroded or missing		Clean, repair and replace	Routine

Source: *Manual for Maintenance of Roads, IRC 1989*

It is important to emphasise that the overall condition assessments are only useful for the main programming and budgeting process. For the purpose of planning specific maintenance works, there is a need for more detailed conditions surveys.

## Pavement Condition Index, PCI

Most road agencies in the country use a standardised pavement condition index as an indicator to describe the overall condition of the road or a road section. This grading of the quality of the pavement is described in the PMGSY Operations Manual<sup>13</sup> and is summarised in the table below.

Surface condition	Pavement Condition Index, PCI	Riding comfort at 50 km/h	Normal driving speed
Very good	5	Smooth and pleasant ride	Over 40 km/h
Good	4	Comfortable	30 to 40 km/h
Fair	3	Slightly uncomfortable	20 to 30 km/h
Poor	2	Rough and bumpy	10 to 20 km/h
Very poor	1	Dangerous	Less than 10 km/h

The pavement condition index is an indicator of the smoothness of the surface and the level of comfort at which the traffic can travel on the road. Since it only refers to the road surface, it is not an indicator of the condition of the road as a whole. A complete assessment of the road would also include the condition of off-carriageway components such as the drainage system and all structures.

Still, this indicator is useful for describing the condition of a pavement, as it provides a fair picture of its current quality. If this is linked to basic asset management principles, one can argue that the objective of the maintenance works is to protect the good roads to a level of quality that provides users with a comfortable ride. Equally, one would assume that

<sup>13</sup> PMGSY Operations Manual, National Rural Roads Development Agency, Ministry of Rural Development, 2005

roads providing slightly uncomfortable travel would need more maintenance inputs, such as periodic renewal, to once again secure a smooth and pleasant ride. Rough and bumpy roads, only allowing travel speeds up to 20 km/h, would require substantial improvement works.

It is interesting to note that the definition of a very good pavement condition index has been defined as a road allowing a smooth ride at only 40 km/h. Although this criterion is lower than for higher category roads, it is in line with the design speeds recommended for rural roads.

From the point of view of deciding where to carry out routine and periodic maintenance, or placing the road under the rehabilitation programme, one could categorise the roads into three conditions only i.e. good, fair and poor condition. This would imply that very good and good roads are grouped together and included in the routine maintenance programme. Fair roads would be considered for both routine and period maintenance while the poor and very poor roads would constitute the group of roads to be considered for rehabilitation and improvement works.

## Drainage assessment

As mentioned, the quality of a road is not only determined by the condition of the pavement is also dependent on the quality of the accompanying drainage system. For rural roads, water is the main cause of damage to the pavement. The PMGSY Operations Manual has adopted the AASHTO<sup>14</sup> definition of the quality of drainage as shown in the table below.

Quality of drainage	Water removed within
Excellent	2 hours
Good	1 day
Fair	1 week
Poor	1 month
Very poor	water will not drain

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<sup>14</sup> American Association of State Highway and Transportation Officials

However, this table does not provide full guidance on the importance of the drainage system. Experience clearly shows that when the drainage system fails, resulting in stagnant water on or around the road, the pavement deteriorates rapidly. While a pavement in fair condition according to the pavement condition index may survive for some time, damages will take place within a short period of time if the drainage system is in a fair condition as defined in the table above.

This implies that when performing maintenance, it is important to ensure that the drainage system remains in good condition and preferably in an excellent condition. Moreover, restoring good drainage can often be carried out through inexpensive measures (i.e. cleaning culvert pipes and re-excavating drains), which have a significant impact in terms of limiting further deterioration of any road - no matter which condition it is in.



Fig 4.20: Stagnant water on shoulders

### Overall classification of a road

Both the pavement and the drainage system need to be included in any assessment of the condition of a road. From an asset protection point of view, it is clear that the upkeep of a functioning drainage system is of the



highest importance. When carrying out road condition surveys, it is often seen that the poor performance of the drainage system is the root cause of damages to the pavement. For this reason, it is important that both the pavement and the drainage are considered when assessing the condition of a road.

Activity	Productivity guidelines for routine maintenance					Notes:
	Unit	Task difficulty				
Inspection 5.0 km/day		1	2	3	4	
Clean culverts + inlets and outlets	as shown	5 rows/wd	3 rows/wd	1 wd/row	2 wd/row	Difficulty = Silt depth in culvert 1. Up to ¼ 2. ¼ to ½ 3. ½ to ¾ 4. Over ¾. Tasks for 600 dia. culverts with 6 rings
Clear debris from bridges	m³/wd	0.5	2.5			Difficulty = type of work 1. Removing loose debris. 2. Excavating silt
Clean side drains	m³/wd	4.0	3.5	3.0		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Clean mitre drains	m³/wd	4.0	3.5	3.0		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Repair scour checks	No/wd	6				
Side slope repair	m³/wd	2.5	2.0	1.5		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Shoulder repair	m³/wd	2.5	2.0	1.5		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Patch potholes in gravel surface	m³/wd	1.7	1.5	1.3		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Fill ruts in gravel surface	m³/wd	1.7	1.5	1.3		Difficulty = soil condition 1. moist and loose 2. average 3. hard and dry
Grub shoulders*	m/wd	200				
Grass cutting and bush clearing	m²/wd	300	200			Difficulty = Denseness of vegetation: 1. Light 2. Dense
Grass planting	m²/wd	3				

\* Tasks measured in linear metres covering both sides of the road.

## 4.8 Technology choice

There is considerable scope for increasing efficiency in road maintenance by adopting work methods and approaches relying to a large extent on locally available resources. A combined use of labour and machines often provides the most appropriate solution. Certain maintenance tasks are more effectively carried out using machines, while others work activities are best carried out using manual labour. The most appropriate technology depends on the nature of the work and the availability of labour and equipment in the area.

Most routine maintenance activities consist of work that requires limited amounts of equipment, mainly relying on basic hand tools and manual labour. When such works are carried out on a regular basis, the amount of work required on a road in good or fair condition is limited. The table below show some common routine maintenance activities and the labour inputs required to carry out such works.

Although the nature of the work is fairly simple and requires limited technical skills, there is a need for oversight from technical staff who have a full understanding of how the various components of the road function and how the maintenance works can best preserve the road. The challenge in terms of maintaining a large rural road network is related to the large geographical area where the work is located.

Routine maintenance work can easily be packaged into small contracts let out to local contractors based in the vicinity of the roads. Due to the limited size of the works contracts, this type of work is more attractive to smaller firms. Small-scale contractors exist in larger numbers and are also found in the rural and more remote parts of the country. For this reason, they are ideal for execution of routine maintenance works. Since the works require limited technical skills and equipment, these firms are appropriate for carrying out such work. Equally, the limited size of the maintenance contracts is compatible with their financial capacity.

From a logistical point of view, it is also preferable to recruit local firms for such purposes. Local firms can more easily mobilise the necessary human and technical resources required for routine maintenance works. Furthermore smaller firms normally operate with lower overheads, which also limit indirect costs and generally lead to lower prices.

In places where there is still a significant departmental labour force in the road agencies, experience show that routine maintenance can be effectively carried out using this human resource.

Periodic maintenance generally involves larger volumes of resurfacing works. The appropriate selection of contractors for such work very much depends on the configuration of the local construction industry. In places where there is an ample supply of medium and larger firms in possession of common road construction equipment, it would be natural to utilise these firms for periodic works. Side-by-side, capacity of local small contractors should also be enhanced to be able to take up such activities.



Fig 4.21: Resealing works in Meghalaya

In more remote areas, there is often a shortage of larger firms. In such circumstances, it is more appropriate to package periodic maintenance works into smaller lots, thereby allowing smaller firms to participate.

Engaging local contractors in road maintenance is not only boosting the local construction industry, it is also useful in terms of building local capacity to deal with emergency maintenance works. Local firms with a competence in road maintenance works can be mobilised more easily and quickly when an emergency occurs and traffic access needs to be restored.

## 5 Institutional arrangements

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### 5.1 Organization

Roads are organised in a hierarchy according to the role they play in the network. Village Roads and Other District Roads provide basic access in rural areas. State Highways and Major District Roads comprising the secondary roads provide both mobility and access function. The National Highways constitute the primary network. Maintenance of the public road network is shared between several organizations depending on the category of the road. The network of roads is managed by state and federal agencies. At state level, public works departments, agriculture marketing boards and rural engineering services are in charge of village roads. In addition, the Panchayati Raj Institutions are in charge of a large network of other rural roads.

Road standards are usually determined by the function of the road and the traffic volumes they cater for. Equally, the road maintenance arrangements vary depending on the function of the road. Main roads with higher traffic levels are given higher priority in maintenance programmes than local roads. Also the responsiveness and service levels in terms of addressing maintenance needs are higher on main roads than on rural roads. Such priorities influence how resources are allocated to the road network and also how maintenance is organised.

Institutional arrangements for maintenance of rural roads include:

- (i) responsibilities of organizations involved in planning and implementation and relationships between them;
- (ii) funding organizations and their relationships with planning and implementation agencies;
- (iii) coordination between agencies responsible for various categories of roads;
- (iv) role of democratic and consultative processes in decision making (to ensure participation of relevant stakeholders), and

- (v) role of the private sector in implementation and supervision arrangements.

The responsibility for maintenance of roads is closely linked to ownership. The rural road network is under the jurisdiction of the state and local government authorities. Not only are they tasked with maintaining these assets, but they are also the owners of the infrastructure. In practice, when government institutions build roads or other infrastructure, such assets end up under their ownership and it is their responsibility to maintain the assets.



Fig 5.1: Time for preventive maintenance

The upkeep of national highways is vested with the Ministry of Road Transport and Highways and as such is the responsibility of the union government. For implementation of development and maintenance, the Ministry entrust the highways to the National Highways Authority of India, Border Roads organization and the State PWDs. State governments are responsible for State Highways, Major District Roads, Other District Roads and Village Roads. At local level, Panchayati Raj Institutions are tasked with the provision of local infrastructure as well as local access roads. This also includes the maintenance of such assets.

Each of these levels of government makes arrangements to protect their respective infrastructure investments by assigning the responsibility for the maintenance to designated technical agencies. For roads under the jurisdiction of the state governments, this responsibility

is delegated to the Public Works Departments or similar institutions. The maintenance responsibility of rural roads forming part of the state road networks may also be delegated to other institutions such as agriculture marketing boards or rural engineering service departments.

The Panchayati Raj institutions constitute the lowest level of government with a mandate focusing on local development. As part of this responsibility, PRIs are involved in various rural development programmes which involve the development of local infrastructure. Some of these schemes are funded by the state or federal government but implemented through local government. A major challenge for the PRIs is the limited technical capacity they can afford to keep within their administrations. In recognition of these limitations, there are often specialised agencies that provide technical support to the PRIs in relation to local infrastructure provision.

A major portion of the rural road network has been built by schemes under the direction of the PRIs with support from technical agencies such as the Rural Engineering Services. Construction of local roads often features as a significant component of rural development schemes as the



Fig 5.2: Local road, Punjab

need for improved access is often regarded as a high priority in many rural communities. This infrastructure constitutes major assets and also needs to be protected from deteriorating. The benefits of these roads will only be sustained if they are provided regular maintenance. It is therefore important that adequate arrangements are made within the PRIs and the supporting technical agencies, to ensure that maintenance also takes place on this portion of the rural road network.

Rural development programmes have in the past focused only on the construction of new roads. This strategy needs to change, introducing a balance between constructing new roads and maintaining existing assets. The benefits of rural development schemes will only be sustained if the infrastructure assets are protected. On-going programmes and also future ones would be more effective if basic maintenance concepts are introduced in these schemes. This is not an impossible task. After all, the PRIs have managed to mobilise technical support to build such infrastructure. On this basis, it should also be possible to make similar arrangements for maintaining infrastructure assets.

## 5.2 Maintenance arrangements

The government, at central and local level, through its relevant agencies, holds the ownership of and responsibility for the maintenance and operation of the public road network. Within this context, there are a number of arrangements that can be used for implementing the actual maintenance works - as shown in the table below. The chosen road maintenance arrangement may also comprise of several of these approaches.

The combination of approaches 1 and 2 was normally used in the past by the technical agencies in charge of road maintenance. Some states still have a significant departmental labour force which maintains a significant portion of their respective road network. Most states however, have disbanded their force account units and instead rely on the private sector for the execution of maintenance works. When road works are carried out as a force account operation, equipment, materials and labour are provided directly by the agency. The effectiveness of these



Implementation arrangements	
1	Paid permanent staff supported by equipment
2	Paid casual workers for defined tasks
3	Direct contracts with individuals or groups (payment by result)
4	Contracts with small, medium and large scale contractors
5	Agreements with communities
6	Agreements with defined village level organizations
7	Self-help: (i) voluntary (ii) collect funds and hire people or contractors (iii) collect funds and combine self-help with rented equipment inputs

approaches is dependent on the availability of equipment, materials and adequate supervision.

The third approach covers the lengthman system, which has been applied with reasonable success in other countries.<sup>15</sup> Although this arrangement in principle relies on a contract in which the workers are paid on the basis of outputs, it is often experienced that due to limited supervision resources, the payments end up being based on attendance – and in effect resembling previous force account arrangements. The drawback with these systems is that, (i) due to the lack of production related incentives, productivity rates can be low, and

(ii) with the limited supervision provided to the individual workers, the work performed is often ineffective or it does not address the real maintenance priorities.

There has been a drive in recent years to move away from public sector execution of civil works and instead relying more on the services of the private sector. Contracting out maintenance may not necessarily follow conventional contracting procedures. Certainly for routine maintenance, it has been possible to contract out work to petty contractors and community groups. Since many maintenance activities can be effectively carried out using manual labour, such works can also be integrated into employment generation schemes.

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<sup>15</sup> In Nepal, routine maintenance of feeder roads is organised through a lengthman system.

The alternative approaches 3 to 7 are likely to require more technical and managerial inputs, especially in the development phase. Despite this initial organization requirement, it is often the experience that contracts with specific groups eventually demand less supervision, are more transparent and by basing payments entirely on work outputs, become more cost effective. When engaging contractors, communities or other local organizations, agreements are made based on work outputs or performance indicators. The actual supervision of the individual workers is then delegated to the contractors, and the concern of the technical agency is of monitoring the outputs of these contractors.

Experience also shows that contracts with a group of workers facilitate a greater emphasis on prioritisation of work activities according to the real maintenance needs of the various road components. As the daily supervision of the workers is delegated to the contractor, the supervisors and inspectors of the road agencies can focus their efforts on more qualitative instruction, guidance enforcing output standards, certifying completion of maintenance tasks based on measurements and recommending payments to contractors by the concerned authority in the road agency.

To effectively apply any of these approaches, the key elements are (i) the establishment of a performance or output based system, and (ii) proper guidance and motivation of the workers and their supervisors.

Despite the fact that the use of departmental labour is no longer “in fashion”, it is important to acknowledge that some of these agencies actually contained all the prerequisites for a successful road maintenance programme, such as a clear mandate, available financial and human resources, technical and administrative procedures, planning and resource management systems, work procedures and standards and progress monitoring. A common argument used in favour of force account operations is that such organizations are more easily mobilised for emergency works as compared to relying on contractors for such activities.

Local roads are at times built through community self-help arrangements. When it comes to installing a maintenance system for these roads, inputs

in the form of regular cash wages is necessary in order to secure continuous and sustainable maintenance arrangements. Although villagers can be mobilised on a voluntary basis to build or improve a short road section, experience shows that such arrangements are difficult, if not impossible to sustain in the long term.

All these approaches are dependent on a solid planning and management capacity and adequate supervision, thus ensuring that work is effectively carried out. Planning and work supervision require an effective organization with a team of skilled engineers and technicians with intimate knowledge of the road network under their supervision. Such staff needs to be equipped with the required resources to operate and remain responsive to the wear and tear of the assets found in the road network.

The issue of management capacity and supervision is related to the level to which the maintenance responsibility is delegated. In order for the management organization to be sufficiently responsive to the demands of the network, it is crucial for its success that it is decentralised. Sufficient authority needs to be vested in the field units, enabling them to take necessary decisions and action in a timely manner, and when doing so, having the required resources for carrying out the works.



Fig 5.3: Maintenance by departmental labour in Himachal Pradesh

Funds for maintenance should be directed to and controlled by the field units as they are expected to manage and supervise works. This implies that contracts need to be managed by the field units and that funds are at their disposal for timely payment of completed works. Based on progress and expenditure reporting, funds are replenished on a regular basis.

### 5.3 Capacity of technical agency

Effective maintenance of a rural road network is a serious responsibility in which technical, financial and institutional issues need to be addressed in a comprehensive and structured manner. Often, the lack of maintenance is blamed in its entirety on the shortage of funding. However, the situation is in most cases more diverse. In places where road maintenance is failing, it is often possible to detect capacity problems in terms of planning and works implementation.

Like any other civil works programme, the efficient implementation of rural road maintenance works requires a sound technical organization equipped with the necessary managerial and technical skills and resources. The performance of the road assets needs to be carefully monitored to ensure that they function as originally intended. When road defects develop, there needs to be established procedures and resources available allowing for timely remedial action. This will ensure that access is restored minimising the inconvenience caused to the users of the infrastructure.

All maintenance works require careful planning, supervision and control. Proper monitoring of outputs and the resources required to achieve these outputs provide the basic information for planning and estimating future maintenance works. However, before these planning and implementation activities can commence there is a need for proper and regular road condition inspection and defects assessments, which form the basis for all consecutive engineering inputs.

The authority in charge therefore needs to be equipped with adequate management tools, including:

- Means and procedures for establishing and maintaining a road

- inventory, providing detailed information about the road assets;
- Established procedures for and logistical means to carry out regular inspection of the network;
  - Guidance on how and when maintenance works should be carried out including procedures on how priorities are set for selection of where maintenance should first be carried out;
  - Programming and budgeting procedures for the preparation of master plans, periodic plans and annual plans;
  - Works implementation procedures: guidelines on choice of technology, use of the private sector and contracting arrangements;
  - Skilled staff to carry out planning and works supervision;
  - Logistical means to oversee the performance of the network and inspection of works;
  - Financial and administrative support services to ensure effective budgetary and expenditure control.

## 5.4 Structure

Institutional capacity to perform efficient and timely maintenance involves the capacity to plan and carry out the works at the right time, preserving investments with cost-effective solutions and thereby utilising available funding resources in the most efficient manner. This requires:

- ✓ competent technical staff,
- ✓ a thorough knowledge of the 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 and
- ✓ reliable financial management.

As far as the actual implementation of works is concerned, procedures and systems need to be in place for planning, budget preparation, payment, monitoring and accounting.

For the planning of maintenance, the first prerequisite is collection of information of the road network. First of all, this implies data is available on the size of the network and its condition. Budget preparation requires information on the cost of routine and periodic maintenance. This is usually available from the technical agencies dealing with road works. Accounting procedures need to reflect the various types of work carried out and meet the reporting requirements of the various funding sources. Procurement procedures obviously vary according to whether the works are carried out by departmental labour or by the private sector. The latter involves a significant reduction in the number of financial transactions for the local accountants.

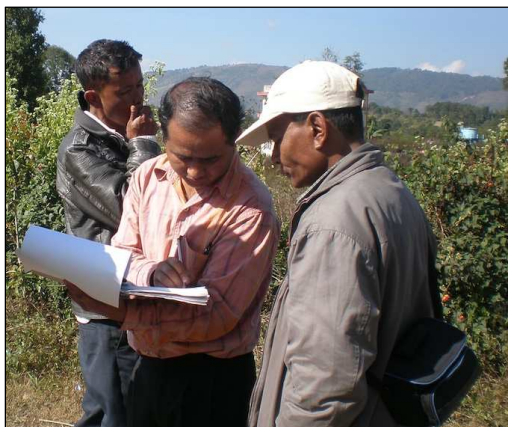


Fig 5.4: Inspecting and recording maintenance needs

Monitoring is important as it provides information on the effective utilisation of the resources allocated and also on the effect of the interventions. The rural road agencies may consider creating a dedicated maintenance cell at the Head Quarters for proper planning and asset management of rural road network under their ownership. Such a unit can be headed by an SE level officer with appropriate supporting staff.

Besides the choice of approach and implementation arrangements, the type of maintenance activities influences the organizational set-up. An effective road works organization needs to cater for all types of work, covering routine, periodic and emergency maintenance. Each of these categories of work requires different organizational setups. The organization needs to be structured in a manner so that it (i) is able to cope with routine maintenance at all times, (ii) has enough capacity to

carry out periodic maintenance, and (iii) is prepared to cater for suddenly appearing emergency works.

The organization of routine maintenance and in particular its management and supervision, needs to be carefully designed in order to meet the specific characteristics of such works.

Although routine maintenance consists of fairly simple work activities, requiring no sophisticated technical skills (i.e. bush-clearing, clearing drains and culverts, pothole patching), it does however demand a cadre of well-trained team of technical staff to supervise the work.

#### ***Tasks of a maintenance unit***

**Inventory:** recording all components of the road network, their main characteristics and current condition.

**Inspection:** examining the road network and measuring and recording its condition.

**Determination of maintenance requirements:** analysing effects, their causes and specifying what maintenance activities are needed to rectify and delay any further deterioration.

**Resource estimation:** deciding the work that has to be done and which works take precedence if resources are limited.

**Work scheduling and implementation:** timing and controlling the works implementation, preparing contracts, award and supervision of works.

**Monitoring:** checking quality, progress and effectiveness of works.

This staff carries out essential management functions such as monitoring the road condition, supervising works, enforcing quality standards and certifying completed works, (ref. Job Description below). To actually achieve this in a timely and efficient manner requires a decentralised organization with skilled staff stationed at strategic locations in relation to the road network.

Additional financial resources for urgent maintenance are important in order to be ready to take prompt action and limiting the extent of damages and avoiding serious disruptions in availability of access to the rural communities. When major natural disasters take place, additional funding should be made available (i.e. major flood damages). For minor

damages, the implementing organization's own resources should be sufficient.

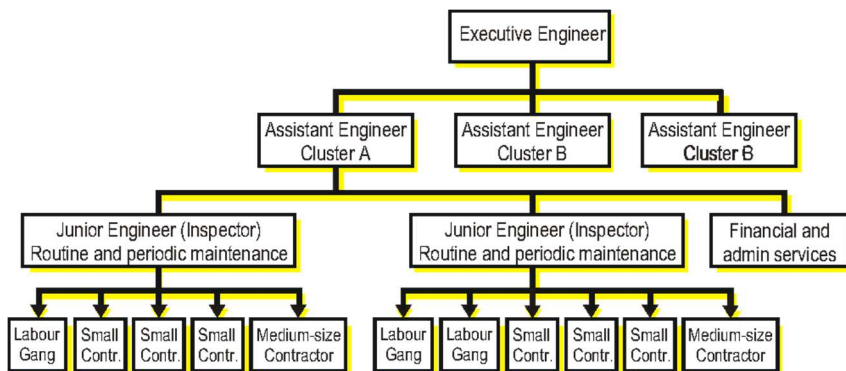
Periodic maintenance works do not require the same continuous monitoring of the road condition as required for routine maintenance. Periodic maintenance is only carried out every five to six years and can therefore be organised in the same manner as construction and improvement works.

A rural road maintenance management team would normally consist of the following cadres of staff:

- An *Executive Engineer* in charge of overall planning and supervision of all rural road works including the maintenance in a district. His/her duties would include overseeing the preparation of cost estimates, work programmes and budgets, contract preparation and tenders and ensuring that works are carried out on time and adequately supervised.
- *Assistant Engineers* assigned to manage the routine and periodic maintenance works in a given cluster or geographical area, providing oversight of work supervision as well as random inspection, measurement and quality control.
- *Junior Engineers* in charge of the detailed programming and implementation of road maintenance for a sub-cluster of roads. These tasks should be combined with the preparation of road condition inventories.
- *Work Supervisors*, where available, support the Junior Engineers in the regular road condition surveys as well as the inspection and supervision of local contractors or labour gangs engaged on routine maintenance works.
- A *Finance Officer* needs to process payments for maintenance works, keep proper accounts, process budgetary allocations and exercise financial control on behalf of the technical team.
- *Administrative and logistical support staff* such as drivers, secretaries and office assistants need to be provided in addition to sufficient means of transport and office equipment.



The organization chart below describes a maintenance unit catering for routine, periodic and emergency works.



The number of Assistant Engineers and Junior Engineers to be assigned to the maintenance works depends on the total physical and financial workload of the required length of roads in the cluster to be maintained. Both routine and periodic maintenance should be entrusted to one Assistant Engineer for a particular cluster of roads - which in turn is subdivided between a team of Junior Engineers. The routine and periodic activities are complimentary to each other and the inventory of the current status of roads has to be prepared simultaneously to assess both routine and periodic works. Therefore it is recommended that maintenance work is entrusted to a single Assistant Engineer in a given cluster. Attention thus paid to routine maintenance can prolong the periodic repair cycle. In road agencies, where it is not possible to allocate dedicated staff for rural road maintenance, the senior management must ensure that the work load for each JE and AE level officer duly takes into account the tasks and supervision involved in looking after maintenance requirements as well.

Depending on the travel distances to reach all roads, a length of 100 to 150 km of roads in plains and 50 to 70 km in hills can be entrusted to one Junior Engineer. This network can be increased if work supervisors are available to assist in condition surveys and supervision of routine maintenance works.

There is no specific personnel assigned to emergency works. Normally, the staff requirements for this activity would be drawn from the regular resources assigned to routine and periodic maintenance. When sudden damages occur to the road network, and immediate action required, it is normal practice to utilise all available resources to deal with the emergency works.

The key personnel in this organization are really the staff in charge of planning and supervising the maintenance works. In practice, Junior Engineers and Work Supervisors can perform this role. These are the persons who actually monitor the condition of the roads and ensure that timely provision of preventive maintenance takes place. The table on next page describes the duties of the Junior Engineer in charge of maintenance.

## 5.5 Training

Most state road agencies implement an in-house training programme for their staff. Training in maintenance has mostly been organised as part of courses essentially dealing with construction works. With a maturing road network in most states, larger portions of road works budgets will need to be allocated to maintenance. As a result, more emphasis therefore needs to be dedicated to maintenance in the annual training calendars.

Many of the topics dealt with in this Guide will require a certain element of training in the process of securing the necessary capacity within the road agencies that ensures that sound maintenance arrangements are established.

For some staff members, the introduction of new management systems and implementation strategies for maintenance involves significant changes in their individual job responsibilities and duties. Training can be used as an effective measure to introduce new management and financial procedures as well as technology.

When designing the training, it is important to acknowledge the variations in maintenance practices across states. Training needs should

### **Job Description – Junior Engineer (in charge of Maintenance)**

#### **General:**

The *Junior Engineer* is in charge of providing and timely maintenance of rural roads. This involves inspection of roads, preparation of budgets and work plans, work supervision, on-the-job training and work guidance, inspecting and certifying completed works, following established technical, administrative and financial procedures.

#### **Main responsibilities:**

The main duties and work responsibilities consist of:

- inspection of all maintainable roads, recording deficiencies and estimating remedial maintenance works,
- estimate annual rural road maintenance budgets and prepare annual maintenance work plans based on field surveys,
- prepare detailed work plans and cost estimates,
- prepare contracts documents for maintenance works,
- estimate required inputs and costs of tools and materials for maintenance,
- assist in procurement of tools and materials,
- identify and select potential local contractors in close proximity to the roads,
- award and negotiate routine maintenance contracts,
- distribute appropriate hand tools to labour gangs,
- monitor and supervise the implementation of works by contractors and labour gangs,
- measure and issue payment certificates for completed works,
- maintain physical progress and cost records of all maintenance works, including labour inputs, tools, materials, and other costs,
- continuously monitor the effect of on-going works as compared to the condition of the road network, and when required introduce revisions to work plans,
- monitor the effects of intensive rainfalls or other extreme wear and tear to the road network, and initiate emergency maintenance measures as and when required,
- monitor and evaluate the effectiveness of work methods, system and procedures, and if necessary propose changes which further improve the efficiency of the system,
- liaise with local authorities and villagers on administrative matters relating to the maintenance works (e.g. safety, use of borrow pits, recruitment of contractors, maintaining road furniture, stockpiling materials, etc.),
- liaise with local authorities and the road users on the proper operation of the roads (speed and weight limitations, reporting, importance of emergency maintenance, etc.)
- other administrative or technical work as directed by the Assistant Engineer.

#### **Reporting:**

The Junior Engineer reports to the Assistant Engineer.

be carefully assessed identifying the main challenges in terms of building up sound maintenance practices based on sustainable asset management principles.

Training needs are not an isolated issue that can be dealt with as a one off exercise. It needs to be continuously assessed. Most states have established regular collaboration with institutions at both state and federal level for the provision of staff training. Equally, there are dedicated institutions that provide training for the private construction industry.

### **Benefits of training**

The effects of targeted skills-oriented training have both immediate and long-term benefits:

- Training can be an effective mechanism for introducing policy change and new management procedures. It can be an effective vehicle for presenting new arrangements to the staff of the agencies concerned.
- The most effective form of quality assurance is provided through well-trained and motivated staff that knows how work should be carried out and takes interest in ensuring that completed works meet prescribed quality norms.
- Training sessions provide a good opportunity for raising awareness of policies and strategies, and improve understanding of key implementation issues, future goals and objectives of the agencies.
- Training opportunities lead to increased job satisfaction and improved morale.
- Providing good in-house staff training opportunities helps attract quality staff to the agency and ensures that new recruits quickly become productive.

When new implementation arrangements are introduced for maintenance, it is important that staff is properly instructed in the new procedures and work methods, thus ensuring that they are put into practice in a uniform and consistent manner.

Experience shows that this type of training needs is therefore best addressed relying to the extent possible on practical sessions in which real planning and implementation scenarios are used. New planning procedures can be introduced through site visits to roads where new

survey methods are demonstrated. Findings from the field surveys can be used for cost estimating and work activity planning. Equally, during the implementation of works, training workshops are useful to ensure that all aspects of effective maintenance are achieved.

The core group for this type of capacity development is the field staff, who on a daily basis takes charge of the planning and supervision of works. This is a large audience stationed at different locations in the respective states. Rather than summoning this group to the centre, training is more effectively carried out with mobile training teams that deliver short-courses where the staff is posted – in close proximity to the road networks for which they are responsible on the job training.



## 6 Planning and implementation

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### 6.1 General framework

The implementation of a road works programme is regulated by a series of procedures and guidelines. These procedures commonly cover subjects such as the planning process, programming and budgeting, procurement and contracting arrangements, technical standards and works specifications, and finally monitoring and reporting. There are also regulations relating to social and environmental aspects that need to be observed in relation to civil works activities. In addition, the institution providing the funding may insist on certain conditions under which the resources are utilised.

Regulating bodies consist of both government organizations as well as private sector organizations. Public works programmes are prepared following the general planning procedures pertaining to the source of the funds and the specific sector under which the programme of works belong. Development plans are commonly produced at state level as well as by local government authorities (i.e. local development plans). Plans at the various levels in the government hierarchy, not only need to adopt certain standard formats, they also have specific approval procedures thereby incorporating basic democratic principles and securing a certain process of consultation with the population who will be affected by the proposed development initiatives.

Setting realistic goals and targets for any type of public services requires good knowledge relating to the costs and amount of resources required to reach these goals. For the purpose of consistency and to ensure that all parties are adhering to the same planning and implementation strategies, a set of standard work practices are developed that include items such as standard designs and working arrangements, catering for the various conditions in which the infrastructure services are expected to operate.

Planning of road works is organised according to the division of responsibility for the network. Main roads and highways are covered by national and state road works agencies, while roads providing access to local communities are under the jurisdiction of local government authorities. In order to distinguish between the main components of the public road network, roads are classified in groups according to their purpose, such as national highways, state highways, and district and village roads.

Appropriate design guidelines have been developed for each of the main road classes. The design guidelines include general directions on the geometric features, such as appropriate dimensions of the road cross-section and curvature, surfacing and pavement options, drainage solutions, road reserves, etc. The guidelines are based on key parameters such as traffic volumes and terrain conditions. In addition to the design standards, standard specifications are issued for how civil works should be carried out. Work specifications are essential in the process of securing that construction and maintenance works meet generally accepted industry quality standards. The Indian Roads Congress has developed design guidelines and work specifications for the road sector – including rural road works, duly supported by the road agencies of the Central and State Government.

## **Annual programmes and budgets**

Annual programmes and budgets are the main plans against which specific resources are dedicated to various work activities. This planning process normally commence a year in advance thereby securing the inputs of all stakeholders and also allowing for the assembly of necessary data to support the cost projections in the budget.

## **Local plans**

In addition to the annual work programmes, road agencies develop long-term plans for the development and maintenance of the road network in their respective jurisdictions. Annual budgets may not meet the full requirements for maintenance and improvements, so a long-term strategy describing when and where works take place are developed based on the



priorities of local political bodies. The timing and contents of maintenance works will vary from one year to another. Periodic maintenance only takes place at intervals of five to six years. For these reasons, it is useful for the road agency to formulate plans covering a period of five years.

## Maintenance plans

Planning is often associated with new development initiatives, however, road agencies also need to include the effective utilisation of available resources to maintain already existing infrastructure assets. As mentioned above, maintenance planning needs to be carried out on a periodic basis as well as on an annual basis.

An important feature of all works planning is to make adequate provision for the upkeep of the existing infrastructure assets developed in the past. Although this issue is often neglected, it would seem obvious that the first priority in any works programme would be to protect already existing infrastructure investments, before spending money on entirely new schemes. For this reason, budgets are divided into a *recurrent or non-plan budget* to deal with the upkeep of existing infrastructure and an *investment or plan budget* for development works. When building new roads or upgrading existing roads to higher standards, funds are sourced from the investment budget.



Fig 6.1: Assessing the condition of a road

## Detailed plans

Detailed plans are the working documents which technical staff refers to in relation to the scheduling of individual work activities, supply of

equipment and materials and hiring of contractors and labour. Detailed plans are prepared for various time horizons, ranging from the entire budget period, to monthly, weekly and daily work plans. The main purpose of the detailed plans is to secure proper management of all resources used as inputs to produce the planned outputs.

The timely completion of works according to a plan is a key determinant in measuring progress and assessing the efficiency of works. In order to obtain an objective picture of progress, a monitoring system is installed in which the actual outputs are measured and compared against the planned work schedule.

## 6.2 Planning maintenance

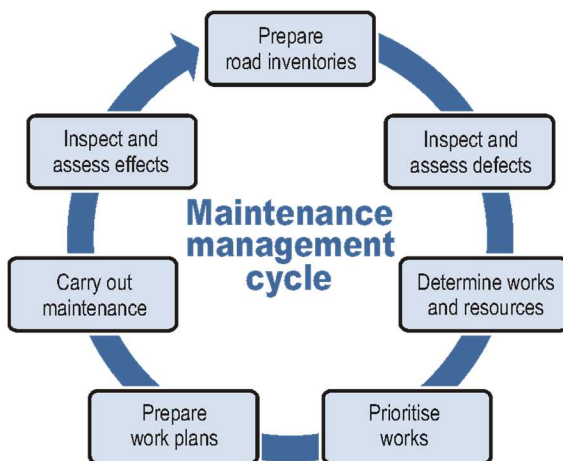
Like any civil works, road maintenance requires careful planning, supervision and monitoring. Before these planning and implementation activities commence, there is a need for a detailed survey of the road condition during which all defects and damages to the road are carefully assessed. This survey provides the basis for planning of the consecutive maintenance works.

As shown in the figure below, the management requirements can be described as a continuous cycle of monitoring, planning and works implementation.

With a complete overview of the maintenance needs, it is possible to allocate available funds where maintenance is most needed. If there is a shortage of funding, it is necessary to allocate available funds where it has the highest effect in terms of preserving the road network.

The funding priorities form the basis for preparing the annual maintenance plans. On the basis of these plans, resources are mobilised for carrying out the works. This includes both in-house resources for

supervision and control as well as contractors and/or force account units executing the works.



Finally, the effect of works needs to be monitored and road condition inventories updated. The monitoring and reporting is also important in terms of documenting that the maintenance budget was spent according to its intended purpose.

An effective road maintenance management system encompasses the entire management cycle as described in the diagram above. While many computerised systems claiming to be a road maintenance management system (RMMS) only focus on the planning and prioritisation of the works, a complete management system for road maintenance also needs to include the works implementation stage, making sure that the right type of works is carried out at the right time. This implies that once road condition surveys have been carried out, the observed damages to the roads need to be translated into quantities of work.

Funding for this work need to be released and contractors or work units mobilised to carry out the works. The completed work is finally measured and paid for. During inspection, a final assessment is carried out to verify that the maintenance provided has actually repaired the

original defects and that no further deterioration is taking place. All these stages require uniform systems and procedures that form part of the management tools of the technical agencies in charge of the road network.

### 6.3 Road inventories

In order to make rational decisions on how a road network can be maintained and improved, it is important to assemble adequate information about its current extent and condition and how it serves the transport needs in the area in which it is located.

Like any other assets owned by the government, it is important to keep records of its components to ensure that they are adequately protected and maintained.

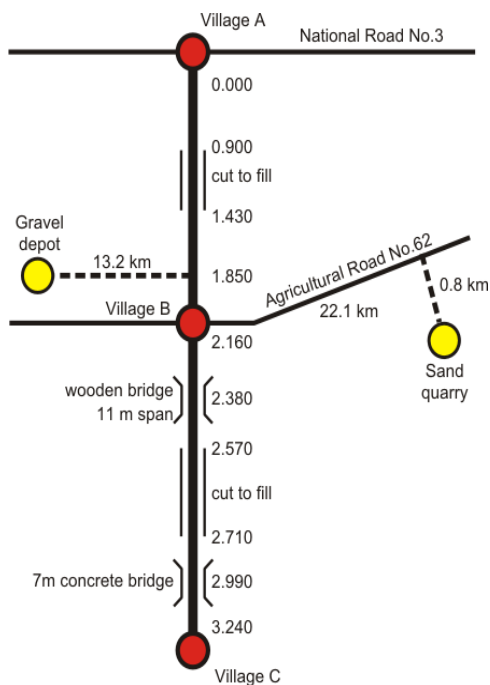
Like any asset register, a road inventory provides details relating to the general features of the infrastructure, including geometric design, alignment, pavement type, traffic volumes and the location of major structures. It may also contain information pertaining to the function and importance of the road, such as the villages served, population and other important infrastructure in the vicinity of the road, such as clinics, schools, irrigation systems, agricultural service centres, government offices, markets, etc.

Road inventories are often described through the use of standard forms in which this information can be recorded.<sup>16</sup> In addition, the location of the road assets are identified with the use of maps describing each individual road as well as the network as a whole. The maps range from simple hand drawn strip maps to advanced computerised graphical information systems (GIS) in which all the data is linked to a digital map. Although modern GI systems are impressive and allow for an efficient management of data, it should be stressed that these systems are not essential for the effective management of information relating to a rural road network. Experience clearly shows that even a simple system of

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<sup>16</sup> The Operations Manual for the PMGSY has designed a good inventory form and also includes useful information on how it is used.

manually prepared strip maps can be an effective planning tool for the development and maintenance of rural roads.



On the basis of the information in the road condition inventory, it is possible to establish the full extent of the network and the portion of roads that should be included in the annual maintenance programme. The road inventory needs to include information on the overall condition of individual roads. This information is important in terms of long-term planning of both maintenance and improvement works. In line with good asset management practices, funding for maintenance works is then secured for the roads in good and fair condition, while the parts of the network in poor

condition is included in future investment programmes for upgrading and improvement works.

By establishing a road inventory with a broad classifications of the condition of the network, it is possible to develop effective long-term plans on how to preserve the network and also how the network can be further improved. The overall size and geographical distribution of the network also form an important basis for resource allocations such as personnel and logistical support and of course funding of works in each of the districts and divisions.

Road inventory information	
<b>Geometry</b>	<ul style="list-style-type: none"> <li>• alignment</li> <li>• profile</li> <li>• cross-section</li> </ul>
<b>Pavement and shoulders</b>	<ul style="list-style-type: none"> <li>• soil conditions</li> <li>• type of pavement and shoulders</li> </ul>
<b>Drainage</b>	<ul style="list-style-type: none"> <li>• culverts and drifts</li> <li>• mitre drains</li> <li>• catch water and cut-off drains</li> </ul>
<b>Bridge Structures</b>	<ul style="list-style-type: none"> <li>• type and size</li> <li>• location</li> </ul>
<b>Road signs</b>	<ul style="list-style-type: none"> <li>• location</li> <li>• condition, visible or not</li> </ul>
<b>Pavement Markings</b>	<ul style="list-style-type: none"> <li>• condition</li> </ul>
<b>Other Traffic Control Devices</b>	<ul style="list-style-type: none"> <li>• specify</li> <li>• location</li> <li>• condition</li> </ul>
<b>Protective works (retaining walls, breast walls, etc.)</b>	<ul style="list-style-type: none"> <li>• location</li> <li>• condition</li> </ul>
<b>Junctions</b>	<ul style="list-style-type: none"> <li>• location</li> <li>• type of connected road</li> </ul>
<b>Condition</b>	<ul style="list-style-type: none"> <li>• overall condition of the road, drainage, bridge structures, road signs, pavement markings, other traffic control devices</li> </ul>
<b>Climate</b>	<ul style="list-style-type: none"> <li>• rainfall</li> <li>• flood patterns</li> <li>• adjacent water management</li> </ul>
<b>Traffic</b>	<ul style="list-style-type: none"> <li>• average daily traffic</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>• details of routine maintenance i.e. names of petty contractors</li> <li>• details on rehabilitation and urgent maintenance works, e.g. date, location</li> </ul>

Equally, by carrying out regular reviews of the overall condition of the network, it is possible to monitor the effects of the investments and priorities taken. With an annual update of the condition of individual roads, it is possible to keep track of the portion of roads in good, fair and poor condition. This is a useful indicator for determining whether the road network is gradually improving or deteriorating, which in turn describes the effectiveness of the maintenance programme and the funding priorities in recent budget allocations.

#### **6.4 Maps and graphical presentations**

Maps form an important basis for the planning of any type of infrastructure. They provide a good graphical presentation of the transport needs and patterns in a given area, and together with data relating to the location of villages, economic activities and social services, it is possible to establish a good overview of the transport situation.

The use of maps for infrastructure planning is carried out at two levels, (i) for the overall planning of development works in a given area, and (ii) for planning specific road maintenance and improvements works.

A basic feature of maps is that they provide a good overview of where people live and how communities are connected together through various means of transport such as roads, tracks, railways, rivers, etc. For development planning purposes, information on economic activities and social services can be added to the map and used during discussions relating to the overall development of a specific region. With the inclusion of such information, it is possible to obtain a good overview of how various sectors interact with each other. From the point of view of establishing an effective road network, the information relating to other sectors can improve the understanding of how the roads provide the necessary transport links required in other sectors (access to schools, clinics, markets, local government headquarters, etc.).

For technical staff in charge of the management of a road network, the use of maps is more specifically related to locating where works are

required in order to maintain and improve the condition of the road network. Maps are therefore used for specifying works in detail and are often included as part of project designs and contract documents. Together with information on the condition of the network, they provide a good overview of the network as a whole.

As mentioned, maps can be produced using various methods. With the increasing application of GIS for rural development purposes, it is often possible to obtain good and up to date digital maps. If these are not available, the alternative is to produce simple road maps from old topographical maps, aerial photographs from Google Maps. Even without such information, simple strip maps can always be produced based on the actual travelling distance measured during road surveys.

## 6.5 Road condition surveys

In order to assess the needs for and to plan future improvement and maintenance works, it is necessary to maintain an up-to-date knowledge of the condition of the road network. For this reason, road condition surveys are carried out on a regular basis. These surveys form the basis for future work programmes and budgets so they need to be carried out well in advance of the next budget approval process. Road condition surveys allow the road agencies to:

- become thoroughly familiar with the road network and its maintenance challenges and on this basis make objective and quantified assessment of the condition of each road,
- make objective prioritisation of maintenance and improvement works in line with sound asset management principles,
- review the effectiveness of maintenance activities carried out since the previous surveys, and
- programme in detail the improvement and maintenance works to be carried out during the next working season.



Due to the size of the rural road network, surveys carried out to monitor its condition are time consuming. Survey procedures therefore need to be designed so that they allow for the data collection to be organised in an effective manner at the required level of detail.

Relevant information on how the road was constructed, including its pavement and geometrical design is often available at the road authority. Some of this information may be relevant in terms of understanding the reasons why damages have taken place. Significant portions of the network have been built using uniform technical standards as part of various rural road development programmes. Knowing the history of the road therefore often provides essential information on how it was built.

### Inspection methods

There are a number of methods used for assessing the condition of the various components of a road. The most common method is to carry out visual inspections. In addition, there exists an array of instruments and equipment used for measuring the quality of the pavement and its surface such as Benkelman beams and roughness integrators.

On rural roads with limited traffic, experience shows that visual inspections are sufficient in order to establish the required maintenance. The structural integrity of the pavement can be assessed on the basis of observed deformations and the extent and nature of cracking. The main concern is to secure a surface seal that prevents water from entering the pavement and the road has a sufficient camber or cross-fall to secure a good runoff.

Road agencies are in charge of an extensive road network and with limited resources it is necessary to assess the condition of the roads in an accurate and timesaving manner. Therefore, it is useful to concentrate on the identification of defects using a set of well-defined key indicators describing the roads. These indicators may change, depending on the environment and topography in which the road is located and also the standards to which it has been built. However, there are some features that need attention on all roads:

- overall performance of the road (i.e. providing all-year access),
- drainage features and performance of cross-drainage structures such as bridges, culverts and causeways,

- quality and performance of pavement,
- extent to which the current design is effective in terms of dealing with weather and traffic without causing excessive maintenance demands,
- containing possible environmental problems such as flooding and soil erosion,
- road safety problem spots.



Fig 6.2: Assessing maintenance needs

The information collected during surveys should be limited to the damages that have an impact on the performance of the road. The objective is to establish a survey method that enables the survey teams to quickly collect the data necessary in order to address all maintenance requirements. Since the entire maintainable road network need to be covered, it is important that time is spent on recording essential data only. The actual survey works should be organised in manner which makes it easy to record the necessary information. For this reason, special forms are used to streamline the data entry. These forms are designed so that the location and extent of the damages are easily recorded. The data entered into the survey forms the basis for estimating the exact quantities of works.

Maintenance works do not involve any changes to the road alignment, so the proposed road works can be recorded in a table briefly recording the condition of the road together with the proposed maintenance where deficiencies are observed. With a standardised form, such as the one

presented below, information can be quickly recorded for any given road section.

The quantities of work will vary along the road alignment, depending on the condition of the road. In order to calculate the volumes of work with a reasonable degree of accuracy, the road is therefore split into shorter segments with uniform features. By referring to the standard cross section

designs used, it is then possible to calculate the exact quantities of work and materials required to carry out the works.

### Estimating patching works

A common practice when surveying surface repair works is to make an estimate of the percentage of the road surface in need of patching instead of specifying the exact location and size of all potholes. A road section in good condition may be assessed as having no more than one percent of its surface in need of patching. With some experience, the survey staff will be able to make such assessments with the required level of accuracy.

When applying this approach, it is however important to carry out more detailed measurements before works commence, thereby ensuring that patching works is carried out at the correct locations and where it is required. Finally, the exact quantities need to be measured in detail upon completion of works.

The time it takes to carry out the surveys very much depends on the condition of the road. Obviously, it is easier and quicker to survey roads in good condition where there is a limited amount of defects. Roads in a fair condition have more defects and require more time to survey. Equally, when there is a backlog of maintenance works, the survey works will be more time consuming.

The main purpose of the condition surveys is to establish a sound basis for planning maintenance works. Maintenance is carried out at different times of the year, i.e. before, during and after seasonal rains.<sup>17</sup> Road condition surveys need to be organised in advance, thereby allowing for the actual works to take place at the right time. Once a practice of regular surveys and undertaking maintenance works has been established, the

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<sup>17</sup>In mountainous areas, maintenance needs to be scheduled to the period when roads are free from snow and when there is no longer any frost.

surveys become less time-consuming as there are fewer damages to record.

Despite forming the basis for all maintenance planning, it needs to be acknowledged that road condition surveys are a time-consuming exercise, requiring a significant number of staff in order to cover an extensive road network. This fact is important as it is often used as an excuse for not carrying out proper surveys on a regular basis. Shortages of staff within road agencies contribute to giving such surveys low priority as compared to other more pressing duties, such as supervising on-going works.

Still, in order to establish an effective maintenance management system, these surveys are required. For this reason, technical staff, either from the road agency or through the involvement of private sector consultancy firms, needs to be allocated to this crucial part of the planning process. It is also worth mentioning that experienced work supervisors, with some basic training and oversight from more experienced engineers, can take charge of such surveys.

### How to use a road condition survey form

Road condition surveys are primarily carried out for the planning of routine maintenance works. With adequate training, they can be performed by work supervisors and junior engineers based in the district or division offices of the road agencies.

Routine maintenance is carried out at regular intervals each year, and the surveys form the basis for planning such work. The surveys collect relevant information on the type and location of the maintenance work. Once a road is surveyed, the exact quantities of work and costs

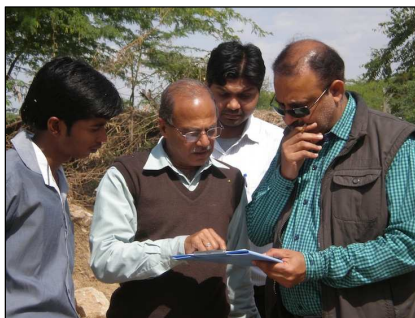


Fig 6.3: Discussing the findings of a road condition survey

can be estimated. These estimates are used when preparing tenders or issuing job instructions to departmental labour gangs.

The survey form streamlines the data collection and also acts as a checklist to ensure that all defects are recorded. In addition, some essential information pertaining to the key design features of the road is recorded. This information is useful for analysing the data collected and calculating the exact quantities of work.

The survey form lists the most common activities carried out when providing routine maintenance. Separate sections are provided to record necessary works on the left and right side of the carriageway. Equally, there is a separate section addressing the need for remedial works on the pavement. Finally there is a section covering other works such as drainage structures, road furniture and other items. Additional works activities can be added to the list when and if required.

The works required are entered indicating the location using the kilometre chainage of the road. Remedial measures are often required over a certain length of the road. The extent of the works is recorded by indicating the start and the finish of the area. For example, a drain that needs to be cleared is recorded as a line showing the start and the end of the works. In addition, the depth of the material to be removed is entered above the line indicating the location. Knowing the original shape of the drain, it is then possible to estimate the exact amount of materials to be removed. The same approach can be used for shoulder repairs, crack sealing, side slope erosion and other activities. By using an easy unit of measurement, which can later be converted into quantities of work, it is possible to speed up the survey works.

The final estimate of total works required on a road can be calculated once back in the office. Using appropriate work norms, it is then possible to determine the amount of materials, tools and labour inputs and finally estimate the costs.

Road Condition Inventory and Maintenance Planning				Road: Village A to Village B										
				Div.			Page: of							
				Last major intervention: month/year										
				Chainage										
				0+000	2	3	4	5	6	7	8	9	1+000	
Road inventory data and condition assessment	Cross section type													
	Carriageway width		m											
	Embankment height		m											
			Type	Cond.	Description									
	Subgrade			G/F/P										
	Subbase													
	Base course		WBM	G										
	Surfacing		PC	G										
Side drain Left (depth)		m	0.3	←-----→										
Side drain Right (depth)		m	0.3	←-----→										
Proposed maintenance interventions				Unit	Qty									
Left side	Bush clearing (width)		m	700	←-----2.0-----→									
	Clear side drains (depth)		m	500	←-----0.30-----→									
	Clear mitre drains (depth)		m	150	←-----0.30-----→									
	Shoulder repair		m	600	←-----→									
	Side slope repair		m		←-----→									
Carriageway	Debris removal				←-----→									
	Pothole patching		m <sup>2</sup>	9	←-----→									
	Base course repair		m <sup>2</sup>											
	Crack sealing		m	400	←-----→									
	Resealing		m <sup>2</sup>	16	←-----→									
	Thin asphalt overlay		m <sup>2</sup>											
	Rejuvenation / fog spray		m <sup>2</sup>											
	Light grading		m <sup>2</sup>											
Camber reshaping		m <sup>2</sup>												
Right side	Bush clearing		m	500	←-----2.5-----→									
	Clear side drains (depth)		m											
	Clear mitre drains (depth)		m											
	Shoulder repair		m	600	←-----→									
	Side slope repair		m		←-----→									
Structures, road furniture, other	Culvert/headwall repair		m											
	Repair retaining wall													
	Minor bridge repair													
	Repair of road signs		no											
	Replacement of road signs		no											
	Road marking repair		m											
	Road marking renewal		m											
Surveyed by:				Date:	Checked by:				Date:					

When carrying out maintenance surveys, it is important to acknowledge that some changes will probably occur between the time of the survey and when the works actually take place. The process of planning the works, tendering and mobilising contractors and maintenance gangs takes time, during which more damages may occur. This is important to bear in mind when choosing the level of detail of the survey works and also in terms of the accuracy of the recording. The main objective of the survey is to record all the types of works necessary and on this basis make a reasonable estimate of the type and volume of work required. The exact quantities of work are more important when recording the actual works performed by a contractor for the purpose of payments.

Roads in good condition and which have received regular maintenance in the past require fewer inputs than roads where limited works have been carried out. When embarking on a maintenance backlog, the survey works require more time and higher levels of detail. On sections with excessive damages, the level of detail may need to be increased and given more time, thereby ensuring that adequate attention is given to all necessary remedial works.

## **6.6 Assessment of maintenance requirements**

The technical agencies in charge of maintenance are responsible for an extensive road network. Within the limits of the resources and time available, it is necessary to assess the roads in an accurate and timesaving manner. It is therefore useful to concentrate on the identification of well-defined indicators to describe the road condition. These key indicators should be defined on the basis of local conditions and requirements. However, there are some features that need high priority on all roads:

### **Drainage**

Drainage is undoubtedly the most important feature of any road. A failed drainage system will cause serious damage to the remaining parts of the road. Common indicators describing the condition of the drainage system are as follows:

Item	Indicator
Culverts, drifts and bridges	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of functionality (correct dimensions)</li> </ul>
Side drains and mitre drains	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of erosion</li> </ul>
Catch-water and cut-off drains	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of erosion</li> <li>• degree of functional length</li> </ul>

To ease inspection effort, the degree of silting/blockage can be described using simple measurements, e.g. fully blocked - half silted - correct size - eroded. This level of detail is normally sufficient to quantify and estimate the cost of the required repair work.

The silting of drains is often linked to the amount of vegetation on shoulders, drains and the inlets/outlets of cross-drainage structures. Uncontrolled vegetation growth reduces water flow and accelerates silt accumulation. Keeping the drainage components free from bushes and regularly cutting the grass will reduce siltation and allow free passage of water.

## Road surface

The most important feature of the running surface is the camber. The lack of a camber or cross-fall on the road carriageway prevents water from being drained off the road, which in turn leads to accelerated deterioration of the road surface. Equally, debris on the road shoulders may compromise the drainage of the road surface.

For the user of the road, the smoothness of the running surface is the most important feature. Defects such as potholes, wheel ruts and damaged edges determine the quality of the surface layer. In addition, it is important to look out for cracks in the bitumen surface since these may allow water to enter the pavement and eventually lead to the formation of potholes.



Severe damages to or debris on the road surface can also pose a danger to traffic. Equally, high vegetation growth on shoulders and side slopes may reduce the line of sight for the traffic and thus reduce traffic safety.

Earth and gravel roads normally require more surface maintenance. The loss of gravel is an important indicator of the quality of the surface on gravel roads. Measurements of remaining gravel thickness should be made at regular intervals along the road at the centre line, in wheel ruts and at the road shoulders.



Fig 6.4: Road surface in need of patching works

Simple indicators for the road surface can be defined as follows:

Item	Indicator
Camber	<ul style="list-style-type: none"> <li>• slope gradient</li> </ul>
Shoulders	<ul style="list-style-type: none"> <li>• average height of accumulated debris and vegetation growth</li> </ul>
Road surface	<ul style="list-style-type: none"> <li>• stone and other debris obstructing traffic</li> <li>• length of road with wheel ruts</li> <li>• pothole percentage of road surface</li> <li>• length of road section affected by corrugation</li> <li>• length of road requiring edge repair</li> <li>• section with significant cracking</li> <li>• length road section in need of new gravel surface</li> </ul>

## Structures

Inspections of structures should not be limited to assess their general appearance but should cover all components of a structure. such as foundations, abutments, piers, beams, bearings, wing walls, etc. The table below provides a checklist of items that should be inspected:

Item	Defect	Item	Defect
Foundation	<ul style="list-style-type: none"> <li>• cracks</li> <li>• erosion along and underneath</li> </ul>	Approaches	<ul style="list-style-type: none"> <li>• drainage</li> <li>• visibility</li> <li>• settlement</li> </ul>
Head and wing walls	<ul style="list-style-type: none"> <li>• cracks</li> <li>• blocked seepageholes</li> <li>• erosion behind walls</li> </ul>	Beams	<ul style="list-style-type: none"> <li>• cracks</li> <li>• bends</li> <li>• corrosion</li> <li>• rotting</li> </ul>
Abutments and piers	<ul style="list-style-type: none"> <li>• cracks</li> <li>• blocked seepageholes</li> <li>• erosion behind abutment</li> </ul>	Waterway	<ul style="list-style-type: none"> <li>• vegetation growth</li> <li>• deposits of sand,silt or organic debris</li> </ul>
Culverts	<ul style="list-style-type: none"> <li>• blocked drainage</li> <li>• blocked or silted</li> <li>• cracks</li> <li>• settlement cracks</li> </ul>	Road furniture	<ul style="list-style-type: none"> <li>• damaged</li> <li>• missing</li> <li>• faded paint</li> </ul>
Decking	<ul style="list-style-type: none"> <li>• loose</li> <li>• drainage</li> </ul>	Banks	<ul style="list-style-type: none"> <li>• eroded</li> </ul>
		Guard rails	<ul style="list-style-type: none"> <li>• damaged</li> <li>• missing</li> </ul>

## 6.7 Prioritising and scheduling maintenance works

Once the road condition inventories have been prepared, technical staff needs to assess the importance of various maintenance interventions. When funding for maintenance is limited, hard decisions need to be made in terms of where the limited funds are best used. The concern is then to figure out how budgets can be best used to preserve the network and which maintenance interventions have the best effect in terms of safeguarding the infrastructure assets.

Among the three types of maintenance, obviously 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 shows that it is the regular or routine maintenance work related to preserving the drainage system which have the most significant impact in terms of extending the lifetime of a road. This work

does not involve any sophisticated technology or skills. It can be carried out using manual labour and simple hand tools and is inexpensive. Despite this, it still requires a sound management organization to ensure that work is carried out at the right place and time.

Adequate routine maintenance extends the design life of the road and delays the point of time when periodic maintenance is required. Actually, with the provision of routine maintenance, it is possible to delay the periodic maintenance when budgets are limited. Experience shows that if routine maintenance is continued on road due for periodic maintenance, it is possible to contain the amount of work required when sufficient funds are finally secured for periodic renewal of the road.

The main cost item in most periodic maintenance is the renewal of the road surface. Eventually the combined effect of water and traffic wears down the surface and although routine maintenance activities such as patching works have been carried out, the surface and its riding comfort will deteriorate and a surface renewal treatment is required.

Essentially, the time at which a renewal is carried out is determined by the extent of the wear of the old surface and its riding quality. This period between surface renewals vary depending on a number of factors including the weather, traffic, quality to which the road was built, strength of the pavement and the extent to which routine maintenance was provided.



Fig 6.5: Mixing bitumen emulsion and aggregate for surfacing works

When allocating funding to various maintenance activities, the first priority is therefore to secure adequate funding for routine and of course keeping a contingency for emergency works. Routine maintenance is

relatively inexpensive as compared to other forms of maintenance such as periodic and emergency works. When properly organised, it is provided at frequent intervals and as such is very much a preventive measure and thus avoiding larger and more costly repairs. As a result, allocating funds to routine maintenance ensures value for money.

### Routine maintenance

Critical elements of the drainage system, such as culverts and drains, need particular attention. Priority is therefore given to the removal of obstacles, debris and silt blocking water from exiting the road in a controlled manner. Erosion channels should be repaired before the next rains deepen and widen them. All these tasks require regular inspection.



Fig 6.6: Rural road in hilly terrain in need of routine maintenance

For each maintenance operation (**r**outine, periodic and urgent), priority lists should be established and provided to the maintenance work teams. They may differ from area to area according to the prevailing conditions. Roads through mountainous areas are prone to landslides and washouts during intense rains and need regular inspections during this period. Equally, in flood prone areas, the proper functioning of cross-drainage structures is vital to the protection of the road embankment from overtopping and washouts.

When priorities are set, the climatic conditions must be considered. Certain activities are more important during the rainy season while others

are best carried out during the dry periods of the year. Obviously, good management of the roads would suggest that the drainage system is in good order before the rains commence. During the rainy season, it is crucial to ensure that the drainage functions as intended. Concrete and bitumen works is best carried out during the dry season.

For each of the climate seasons, different maintenance activities will have a certain priority. For example, grass cutting in the road reserve during the rainy season does not make sense when at the same time the ditches and culverts are left unattended and are becoming seriously silted. The following table provides a list of priorities for routine maintenance according to the season.

Routine maintenance priorities		
Season	Priority	Activity
Before the rains	1	• clean culverts and other cross-drainage
	2	• clean side drains and mitre drains
	3	• clean and repair shoulders
	4	• repair erosion on side slopes and in drains
	5	• patch potholes and seal cracks
	6	• white wash road furniture
During rains	1	• inspect and remove obstacles from roadway and drains
	2	• clean culverts and other cross drainage
	3	• clean side drains, cut-off and mitre drains
	4	• repair side drain erosion
End of rains	1	• repair erosion on shoulders, side slopes and in drains
	2	• repair retaining walls
	3	• cut grass and clear bush
Dry season	1	• repair drainage structures
	2	• repair road shoulders and surface edges
	3	• patch potholes and seal cracks

The table above illustrates the importance of the most common routine maintenance activities. As shown, high emphasis is on keeping the drainage system in good order before and during the rains. This however does not preclude including more work activities at the time when

contractors are mobilised to carry out maintenance. Equally, the road agency may decide to award contracts for routine maintenance works only two or three times a year. This implies that the priorities shown in the table above need to be modified to fit the preferred maintenance schedule.

## Periodic maintenance

Priorities are also important when carrying out periodic maintenance. Again, activities relating to the drainage system should be given particular attention. The table below lists some common periodic maintenance work according to their importance.

Priority	Activity
1	rehabilitation of structures and repair of culverts
2	repair of retaining walls
3	major patching and resealing works

## Emergency maintenance

Urgent maintenance work requires immediate action. Priority should be given to such activities that ensure that the road remains (even partially) passable. For example, a broken culvert may disrupt the passage of traffic and needs to be attended to immediately. While a landslide only covers part of the carriageway, allowing the traffic to pass the affected section, remedial action is still required to clear the full width of the road and remove all debris from the drainage system.

It should be noted that road defects may start as a minor defect, but if left unattended, may escalate into serious damages. For example, debris blocking the flow through a culvert may eventually lead to serious erosion to the adjacent road pavement if left unattended. Therefore, it is important that roads are regularly inspected and particularly during periods of heavy rains.

When urgent repairs are required, the road agency needs to be able to take swift action thereby limiting the extent of damages and in severe cases quickly restore access.

## 6.8 Service levels

Maintenance can be provided with varying degrees of inputs, with the result that the road is kept to different levels of service. For all roads, there is a minimum required maintenance to keep its components functioning as intended such as ensuring that the drainage allows free passage of water and that the carriageway has a water proof seal to protect the base course and provides an even surface for the traffic.

Beyond these protective measures, road authorities may define certain service levels for roads of a given type and function. Highways require higher service levels for the carriageway since the design speed for such roads are much higher than on local roads. Since traffic is expected to travel at higher speeds on highways and therefore demand a smoother running surface. Any defect to the road surface therefore needs to be rectified at an earlier stage. It also means that resurfacing is required at an earlier stage when settlements and patching work accumulate on such roads. For rural roads the surface smoothness is not as critical since vehicles travel at lower speeds and therefore do not require the same high service level.

A key feature defining a given service level is the maximum time allowed before observed damages are repaired. For high volume roads, the prescribed response times are usually shorter. When damages occur on highways, it is more important to quickly take remedial action since the damages often have a serious impact on traffic safety. For rural roads with limited speeds and volumes of traffic, a longer response time can be allowed.

Service levels can be defined for the main road components and may vary according to the geographical conditions and weather patterns. In hilly terrain with high rainfall, it is imperative that the drainage is always in excellent condition, thereby catering for heavy down pours when the drainage needs to perform at its highest capacity. In arid areas with

gentle terrain, the drainage may be of less importance through large parts of the year.

In areas with high rainfall, it is also more important to maintain the road shoulders on a regular basis, thereby ensuring good drainage of the road surface. In arid areas, such work may be once a year activity.

Equally, it is more important that shoulders on roads in populated areas are kept clean to enable pedestrians, bicycles, hand-carts, a safe place to travel.

As mentioned earlier, the service level of the road surface may vary. Rural roads do not need the same surface smoothness as required on highways. While authorities may choose to monitor the evenness of the carriageway of high volume roads using bump integrators and similar equipment, this is less critical on local roads. This also implies that more local patching can be allowed before a full renewal of the surface is required.

Service levels are often defined in performance contracts for road maintenance. These (i) specify the maximum extent of damages that can be tolerated on a road section and (ii) the response time permitted before the contractor needs to take remedial action. Lower service levels would mean more tolerance level before remedial action is required. Service levels can also be defined for payment purposes, using the extent of observed damages on a given road section as the basis for establishing payments due to a contractor.

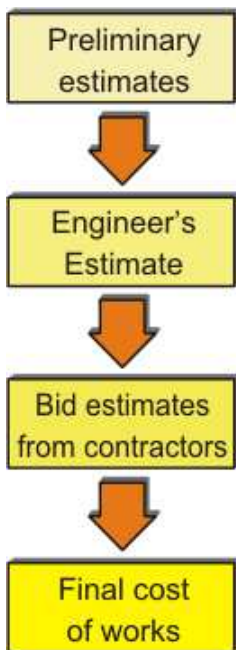
Service levels can also be defined for emergency works, for example by prescribing the maximum time allowed before blockages of roads are cleared. Setting the appropriate service level in this context needs to be carefully considered in relation to the function of the road. In regards to rural roads, it is important to bear in mind that these often provide the sole connection to communities. When such a road is blocked, the communities get isolated. The consequence may be that villagers are unable to reach schools and health facilities. For this reason, roads providing the main connectivity to local communities should be given a high service level in relation to emergency works.



The final choice of service levels is very much a matter of costs and availability of budgets. Rural roads constitute the vast majority of the public road network. The appropriate service level is very much a matter of what the authorities can afford. In many cases, the lowest practical level in which rural road assets remain protected is the only realistic target for the road agencies.

## 6.9 Estimating and budgeting

Accurate cost estimates are essential when planning and managing road maintenance. The road authority needs reliable estimates and cost norms for several reasons. Accurate information on costs allows technical staff to value and compare alternative remedial measures. The estimates form the basis for proper budgeting and financial planning, and allow for proper accounting, and may avoid serious cost under- or over-runs during works implementation.



Estimating costs is not a one-time exercise but a continuous process from the initial inception to the final completion of a works project. At various stages of the project, estimates are produced to varying degrees of detail.

During the initial planning stage, estimates are often based on general cost norms prepared on the basis of the most common maintenance activities. Average cost norms for various types of maintenance are updated on a regular basis by a dedicated committee at federal level. In addition, several state road agencies formulate their own cost norms, taking into account prevailing conditions and practices in their respective states.

Cost estimate for routine maintenance							
District: <b>Ri-Bhoi</b>				Division: <b>Umsning</b>			
Sub-Division: <b>Bhoi Rymbong</b>				Road Category: <b>ODR</b>			
Road Name: <b>Khapmar - Pynthor</b>				Length: <b>8.00</b> km			
No.	Activities	Unit	Quantity	Unit Rate	Amount	Time/year	Total, Rs
1	Pothole patching	m <sup>2</sup>	9.6	600	5,760	1	5,760
2	Crack sealing	m	22	30	660	1	660
3	Sealing coat	m <sup>2</sup>	430	70	30,100	1	30,100
4	Thin overlay 20mm	m <sup>2</sup>	185	200	37,000	1	37,000
5	Leveling course	m <sup>2</sup>					
6	Base course repair	m <sup>3</sup>					
7	Camber reshaping	m					
8	Regravelling	m					
9	Clear side drains	m	6,200	15	93,000	2	186,000
10	Clear mitre drains	m	45	15	675	2	1,350
11	Lower berm	m <sup>2</sup>	1,150	15	17,250	1	17,250
12	Shoulder repair	m	42	30	1,260	1	1,260
13	Side slope repair	m	35	30	1,050	1	1,050
14	Clear culvert/bridge	m <sup>3</sup>	21	98	2,058	2	4,116
15	Repair culvert/bridge	no.					
16	Bush clearing	m <sup>2</sup>	11,000	1	11,000	2	22,000
17	Repair road signs	no.					
	Other						
<b>TOTAL</b>					<b>199,813</b>		<b>306,546</b>
						Average cost per km	38,318
Date:		Date:		Date:			
Prepared by:		Checked by:		Counter-signed by:			

When works are planned in detail, more accurate estimates are required based on field surveys during which the specific maintenance requirements are assessed. On this basis, it is possible to prepare detailed work plans and budgets. These estimates are also referred to as the Engineer's Estimate or detailed estimate when tendering the works. The table below provides a sample of how detailed estimates of routine maintenance works can be presented.

Contractors produce their own estimates when they bid for works. Reliable cost estimates are essential in order for the contractor to stay in

business. Contractors need to assess the likely expenses related to their work activities, thereby being able to control profits and losses.

During the execution of a contract, modifications are made to the original plan. Unforeseen site conditions may warrant changes to be made to the contract, which may have financial implications. When modifications are made, earlier cost estimates need to be revised. Finally, price increases on materials, wages and services may lead to increased costs during works implementation.

All expenses incurred are monitored for budget control and also to allow planners to update their cost norms in order to secure accurate estimating in the future.

## 6.10 Work preparations

There are several stages of preparatory work before a maintenance works programme can commence. The adjacent figure shows the sequence of preparatory activities that needs to be timed properly in advance in order to secure that the road maintenance works take place when it is planned for.

First, it is necessary to establish what the maintenance requirements consist of. All maintenance planning is based on field surveys where the actual condition of the road is assessed in detail. Based on the defects observed, work estimates are recorded into survey forms according to its location. Once the survey is complete, the works need to be scheduled to the most appropriate time of the year.

Some work activities require the supply of tools and materials. When works are carried out by departmental labour, materials need to be purchased and delivered to the work sites in advance of commencing works. Hand tools may



Fig 6.7: Planning maintenance works

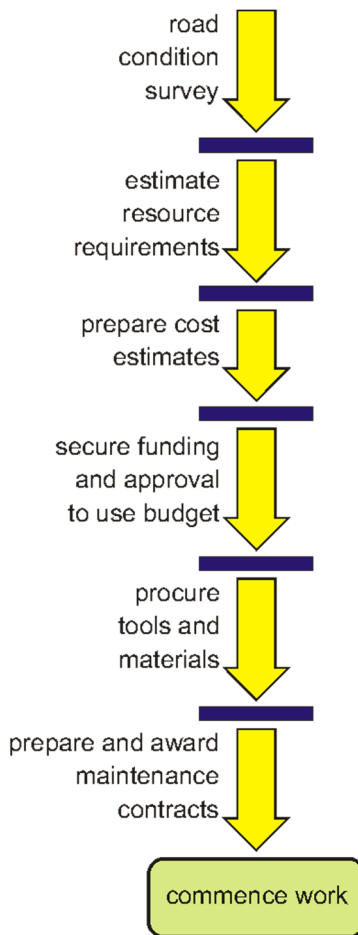
need to be replenished, and when new roads are placed under maintenance, there may be a demand for additional tools.

When relying on private contractors, the tendering process needs to be carried out well in advance to secure that the maintenance works take place at the correct time of the year. It is useful to complete the plans for all roads to be placed under maintenance in order to streamline the tender process.

These resources, as well as mobilising contractors, require that funds have been approved well in advance of commencing works. The detailed budgets are then included in the annual maintenance works programme.

Once the necessary budget has been secured, detailed work plans are updated for each road. More substantial works such as periodic maintenance can be planned using time location and bar charts. It is only when all these activities have been completed that the hiring of contractors should take place.

Finally, it should be stressed that the maintenance plan needs to be carefully monitored and compared to the real needs of the road network during the course of the year. Additional damages are likely to occur during the course of the planning and implementation period, which may require revisions of the original work plans.



## Design of road maintenance works

Road maintenance works are normally not designed to the level of detail as is common practice for construction works. The full design of the road was carried out during its initial construction. Most maintenance works involves repairs to reinstate the road to its original condition and design. Instead, the main emphasis when planning road maintenance is to identify the location and extent of the damages and at the same time suggest the remedial measures.

This applies to most of the routine works and also a majority of periodic maintenance. Emergency maintenance involving reconstruction of road sections and water crossings may at times need proper designs - which also seek to avoid a recurrence of the damages.

At times, there is a need to improve on existing designs. Additional retaining structures may be necessary in areas prone to landslides. Equally, there may be a need to install additional cross-drainage structures and other drainage components may appear to be prone to erosion and/or silting. Strictly speaking, when new designs are introduced to an existing road, such works are beyond the confines of road maintenance and come under work classifications such as upgrading and improvement works – and should ideally be funded under the capital investment budgets. Minor works of this nature is however often included and scheduled as part of the regular maintenance programme. As any improvement works, it would need a higher level of detail in its design.

### 6.11 Work programme

Work programmes are essentially the detailed plans used for works that have been approved and for which adequate funding has been secured. The works programmes are prepared to various levels of detail. The core of the work programming process is the overall plans for each road works site from the start of works until completion.

### Workplan Routine Road Maintenance

District: ..... Division: ..... Road name: ..... Total length ..... km Page ... of ...

ACTIVITY	Unit	Qty	Task rate	Work days	0-100	1	2	3	4	5	6	7	8	9
Left	Bush clearing (width)													
	Clear side drains (depth)													
	Clear mitre drains (depth)													
	Shoulder repair													
	Shoulder regravelling													
	Side slope repair													
Carriageway	Clean adjacent drainage canal													
	Debris removal													
	Pothole patching													
	Minor pavement repair													
	Crack sealing													
	Local patching / seal repair													
Right	Thin asphalt overlay													
	Rejuvenation/fog spray													
	Light grading													
	Bush clearing (width)													
	Clear side drains (depth)													
	Clear mitre drains (depth)													
Structures, furniture	Shoulder repair													
	Shoulder regravelling													
	Side slope repair													
	Clean adjacent drainage canal													
	Minor culvert/headwall repair													
	Repair of retaining walls													
Total	Repair of road signs													
	Road marking repair													

Prepared by: ..... Date: .....

A works programme for a particular road includes details of all work activities and their respective inputs, their location and a schedule indicating when the events will take place.

These work programmes can be broken down into detailed weekly and daily work plans. Equally, the work programmes of each of the roads are summarised in consolidated work programmes covering all the projects approved in a budget year.

For larger projects, such as when carrying out periodic maintenance, the work programmes are presented in similar formats as for road construction and improvement projects. For routine maintenance, the work programme can be simplified and presented in a form similar to the format used when carrying out road condition assessments.

## **6.12 Safety at the work site**

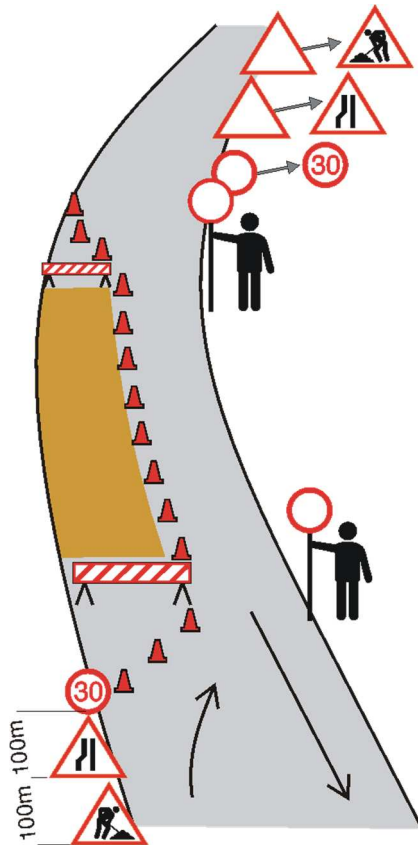
There is clear evidence that accident rates increase on road sections where works are taking place - as compared to when the road is in good order and free from any obstructing work activities. To reduce the risk of accidents where road works take place, it is necessary to install adequate safety measures.

Speed limits should be reduced well in advance of the work site. At the same place, road signs should be placed to warn the traffic of the work ahead. It is important to install sufficient measures to ensure that the speed of traffic is reduced before it arrives at the work site.

At the work site, all damages to the road which pose a danger to the traffic should be properly marked so that the traffic is guided away at a safe distance. Equally, the traffic should be properly separated from where works take place. The work site needs to be protected so that the traffic does not pose any danger to the workers, materials or equipment.

Simple and inexpensive safety equipment such as traffic cones can improve safety for both the road users as well as the maintenance workers. Cones are useful for (i) alerting the traffic of road works ahead, (ii) guiding the traffic into diversions and (iii) keeping traffic at a safe distance from the work site. Cones are easy to place and can be quickly moved when the works progress to another location.

Passing traffic pose a major risk to the safety of workers on road maintenance sites. It is therefore important that maintenance workers are clearly seen by the traffic. Work uniforms or vests in clear bright colours should be worn at all times on work sites to protect the workers from passing traffic.



When carrying out surface works on rural roads, movement needs to be regulated, allowing traffic to pass in one direction at a time. The guidelines given in IRC code for safety in work zones should be followed.

Maintenance works essentially need to adhere to the same safety regulations as when carrying out construction works. This applies to both equipment and workers on site as well as in relation to third parties such as traffic passing on the road and people and property in the vicinity of the work sites. Workers on site need to be instructed about potential



hazards and provided with the necessary personal protective equipment thereby reducing the risks of injury and accidents.

### **Use of hot bitumen**

While there is an increasing use of cold bitumen emulsion for surfacing works, the use of hot bitumen remains a common practice in many states. Hot bitumen poses a risk to workers when being used for patching works. Several states still heat bitumen at site and carries out mixing and spreading using manual labour. Health and safety risks can be considerably reduced by replacing this practice with the use of emulsions which do not require any heating. The use of emulsions for maintenance works also has the potential of eliminating the need for firewood or other fuels for heating bitumen and aggregates.

There is considerable scope for improving safety practices on road works sites and this also applies when maintenance is carried out on rural roads. Most measures to improve safety at work sites are inexpensive to implement and are often a matter of setting minimum standards and enforcing these. A key to improving safety therefore lies with the client and its supervisory staff and introducing appropriate procedures for enforcing standard safety measures as part of the regular inspection routines.

## **6.13 Reporting**

The main objective of a maintenance reporting system is to provide programme management with an effective tool for monitoring work progress against approved plans. It is also an important means of documenting expenditure on road maintenance, thereby providing an essential feedback to government authorities on how maintenance budgets are used and how such works have impacted on the quality of the road network.

Reporting can be a resource intensive undertaking. Many sophisticated reporting systems have been developed as part of advanced knowledge information systems without any success. The challenge is to keep the information databases up to date. Therefore, it is important that the systems devised do not require any more data collection than what is

required in terms of supervising works and keeping a reasonable overview of the average cost of works.

Reporting is carried out at several levels, starting at site level where the reports contain the most detailed information. The following information should be provided in site reports:

- road description,
- chainage of road section,
- quantities and location of work carried out,
- targets for each activity,
- costs of completed work.

This information can be recorded in the same form as used for the work plan. When engaging local contractors to carry out road maintenance, the actual work performed is recorded during site inspections. When maintenance is carried out by departmental labour, the same information should be recorded. In order to establish the full costs of force account works, it is also useful to record information relating to:

- task rates used,
- workdays spent on each activity, and
- materials and equipment used.

At headquarters, less detailed reports are compiled, consisting of a summary of the information gathered from all the sites. These reports would normally contain the following information:

- road names and numbers,
- total length of each road or section,
- date when work was executed,
- type of maintenance (routine, periodic or emergency works), and
- the cost of works performed on each road.

The sample forms on the next two pages describe the minimum reporting required for routine and periodic maintenance allowing for the effective tracking of expenditure for such works.

Once this information has been checked and analysed, it is used (i) when carrying out new road condition surveys and (ii) for updating general cost estimates used when preparing and budgeting new maintenance programmes.

Financial Progress of Routine Maintenance						
Name of Division:			Sub-Division:			
Name of road	Length of road (km)	Budget allotment (Rs Lacs)	Routine maintenance (all in Rs Lacs)		Remarks	
			Expenditure up to last quarter	Expenditure during the quarter under review		
			Cumulative expenditure during the year			

Note: The Executive Engineer shall certify that financial figures given are as per the Register of Works (CPWA-41) corresponding to Works Abstract (CPWA-34)

Physical and Financial Progress of Periodic Maintenance											
Name of Division:				Sub-Division:							
Name of road	Job No.	Road length (km)	Sanctioned amount (Rs Lacs)	Achievement up to last financial year		Target for current financial year		Achievement up to last quarter		Achievement during the quarter	
				Physical (km)	Financial (Rs Lacs)	Physical (km)	Financial (Rs Lacs)	Physical (km)	Financial (Rs Lacs)	Physical (km)	Financial (Rs Lacs)
1	2	3	4	5	6	7	8	9	10	11	12

!

Cumulative achievement this year	Overall up to date achievement		Likely completion date	Remarks	
	Physical (km)	Financial (Rs Lacs)			
13	14	15	16	17	18

!



## 7 Contracting

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### 7.1 General

Maintenance of rural roads is a widely dispersed activity, requiring small resource inputs at numerous locations covering a wide geographical area. The amount of work required to keep a road section in good condition depends on several factors such as type of road surface, traffic volumes (numbers and size of vehicles), the severity of climatic conditions, especially rainfall, soil types, the susceptibility of the terrain to erosion, road gradients, topography, presence of bush and vegetation, etc. Routine maintenance is more dispersed than periodic maintenance.

Many routine maintenance activities are well suited for manual labour. Under average conditions, experience show that an input of 10 workdays per month is sufficient to cover the off-carriageway maintenance for a one km road section. Traditionally, routine road maintenance was organised using a lengthman system, based on assigning one person to take care of a section of approximately 1 to 3 kilometres. In the past, public works departments relied on labour gangs to carry out routine maintenance.

The lengthman system is still operated in some countries. However, experience shows that it is difficult to provide adequate supervision and support to all the lengthmen required to maintain an extensive road network. For this reason, many road agencies have organised such work through labour gangs in charge of longer road sections. A gang of workers can also more effectively take on larger work tasks. If some construction equipment is required, the use of a labour gang also produces a more effective balance of labour and equipment.

These days, the use of labour gangs operated by the public works departments is becoming less common. Instead, there is a preference to hiring private contracting firms for carrying out all types of road works – including routine maintenance.

There is a wide range of arrangements that can be used for the contracting out of maintenance works. The work once carried out by departmental labour is these days increasingly carried out by private construction firms. Depending on the type and complexity of the works, different size contractors can be utilised.

## 7.2 Private sector involvement

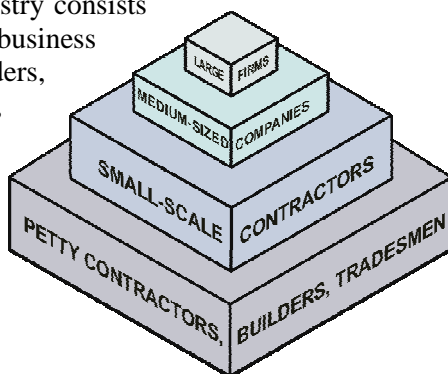
Rural road maintenance can provide the local construction industry with considerable market prospects. Extensive road networks in need of regular maintenance can provide significant amounts of work opportunities every year. Although the interventions in each and single routine maintenance contract do not constitute significant volumes of work, the amounts add up when such work is provided to the entire network. Secondly, routine maintenance needs to be provided to the entire maintainable road network on an annual basis, thereby providing some predictability into the market of local contractors. In addition, there are always a number of roads selected for periodic maintenance every year, thereby further boosting the market prospects of the local construction industry.

Some states still retain a considerable departmental labour force, mainly used to carry out routine maintenance works. Since there is no longer any new recruitment to these units, there is a growing need to find alternative implementation arrangements to replace the diminishing force account units. The logical approach is to start using local contracting firms to fill the gap when force account units are disbanded.

The distribution of small, medium-sized and large contractors follows the same patterns in most places. Large contracting firms are normally relatively few in numbers, often based in urban areas. Small and medium scale contractors are found in larger numbers, some with a permanent presence in the more rural parts of the country.



In addition, the construction industry consists of a great number of smaller business entities consisting of local builders, plumbers, electricians, carpenters, masons, etc. Although these smaller businesses, comparable to petty contractors, are often not registered as contractors, they constitute a significant part of the local construction industry.



### Petty contractors

This category usually consists of one-man firms, sometimes assisted by a limited amount of unskilled workers. They may be labour only contractors, often subcontracted to carry out specific work, mainly relying on casual labour. Local artisans such as bricklayers, carpenters, plumbers and electricians together with their semi-skilled or unskilled work force can be classified as a petty contractor. Local community groups such as farmers associations, village welfare and women self-help groups can also be classified in this category. A common feature for this group is that they are not formally registered.

Besides some simple hand tools, petty contractors normally do not possess any equipment and often lack their own means of transport. These contractors can be used for some routine maintenance works or simple, clearly defined subcontracts requiring a minimum of skilled labour and hand tools.

### Small and medium size contractors

Small and medium size contractors are often characterised as the firms on the lower level of a formal classification scale. They are located all over the country and constitute the majority of available construction firms.

A common feature of this type of firms is that their financial capacity is limited. Some conduct their business through banks while others obtain their credits and maintain their savings and profit through informal

financial channels. Equally, their equipment fleet is limited and restricted in terms of heavy plant requiring large capital investments.

The strength of this group is their proven capacity as entrepreneurs. These firms have all carried out works contracts in the past and evidently managed to secure a profit from their business activities. This implies that they also possess some technical and managerial capacity.

As they are found in the more remote parts of the country, they are attractive partners in rural road maintenance works since they do not need much time and resources in order to mobilise. Equally, they are well known in their local neighbourhood so their strengths and weaknesses are generally known to potential clients.

With some training and sufficient supervision, these contractors can prove highly efficient in carrying out rural road maintenance work. Many show good entrepreneurial drive, and in an enabling environment with a steady supply of work, they can prosper and constitute an important player in a maintenance programme.

### **Large-scale contractors**

Large construction companies are available in limited numbers, often located in major urban centres. The strength of large contractors is their solid financial capacity, wealth of expertise and ability to mobilise any type of equipment.

The involvement of large contractors is only cost-effective for substantial volumes of works confined to a limited geographical area. These firms are often used for rural road construction when works are packaged into reasonably large contract. Due to their normal area of operation, they require longer and costlier mobilisation before they are ready to operate in remote areas. Smaller works widely dispersed over a large area such as rural road maintenance would be less attractive to large contracting firms.

<b>Types of contractors</b>		
<i>Type</i>	<i>Description</i>	<i>Works capacity</i>
Petty contractors	<ul style="list-style-type: none"> <li>• local builders and tradesmen</li> <li>• labour only</li> <li>• limited skills</li> <li>• not registered</li> </ul>	<ul style="list-style-type: none"> <li>• labour only contracts</li> <li>• minor repair works,</li> <li>• off-carriageway maintenance</li> </ul>
Small and medium sized contractors	<ul style="list-style-type: none"> <li>• registered</li> <li>• possess some equipment</li> <li>• limited capital security</li> <li>• good entrepreneurial skills</li> <li>• some technical and managerial skills</li> </ul>	<ul style="list-style-type: none"> <li>• smaller construction works</li> <li>• construction and repair of structures</li> <li>• rural road maintenance and rehabilitation works</li> <li>• Small bridges and culvert works</li> <li>• Limited surfacing works</li> </ul>
Large-scale contractors	<ul style="list-style-type: none"> <li>• registered</li> <li>• good access to equipment and capital</li> <li>• proven entrepreneurial skills</li> <li>• sound technical and managerial capacity</li> </ul>	<ul style="list-style-type: none"> <li>• large infrastructure projects</li> <li>• complex building projects</li> <li>• possess a wide range of construction equipment</li> </ul>

Certain types of work obviously require the involvement of large contractors due to size and complexity of the works. For rural road maintenance, this is however usually not the case. Most of the works is relatively small-scale using mainstream technology that can be sourced from local firms and builders.

### **7.3 Packaging of works**

When road maintenance is carried out by private contractors, works need to be packaged into appropriate sizes and content that matches the capacity and skills of the contracting firms. The distribution of various size contracts can also be used as an active means for utilising the full capacity of the local construction industry. With an appropriate share of

large and small contracts, it may be possible to utilise the available capacity of both large and small construction firms. Works on a cluster of roads may be packaged together into one contract thereby saving mobilisation costs.

A small number of large contracts is easier to prepare and manage. On the other hand, smaller but more numerous contracts let concurrently result in more contractors involved and more works taking place in parallel. Larger number of smaller contracts also tend to reduce risks as opposed to relying on a select few large construction firms.

### **Rural road maintenance in Rajasthan**

All road maintenance work in Rajasthan is carried out by the local private construction industry. Class C and D contractors are commonly engaged in routine maintenance works. Class D contractors are certified to take on contracts up to a value of Rs. 1.5 million. Routine maintenance contracts, often emphasising surface patching works, are normally packaged so that this limit is not exceeded – on average at a value of Rs. 1.0 million. The contracts include a 6-month defects liability period.

Class A and B contractors carry out resealing works. Similarly, the construction contracts under the PMGSY programme is carried out by local Class A contractors.

Asphalt works are carried out using two arrangements. Some contractors have mobile mixing plants and utilise these for the patching works. Other contractors purchase hot-mix asphalt from stationary plants operated by larger firms.

Works are supervised by Assistant Engineers from the Public Works Department.

Contracts can be packaged into specific sizes to attract contracting firms with particular skills. Large contracts attract larger firms with specialised skills and equipment. Smaller firms may not possess such resources and are therefore allocated smaller packages containing works requiring less technical skills. Smaller local firms may be preferred for certain types of work due to lower overheads and mobilisation costs.

Separate contracts are normally organised for routine, periodic and emergency works.<sup>18</sup>The main reason for this is the nature and size of works. Routine maintenance involves simple work activities appropriate for local small firms, while periodic and emergency works contain more advanced work often requiring more technical skills and equipment. The different types of maintenance may be organised through different types of contracts. Routine maintenance works can be organised using performance-based contracts while contracts for periodic works are mostly based on measured quantities.

#### **Involvement of the local construction industry in Himachal Pradesh**

A major challenge in Himachal Pradesh is the short period during which asphalt works can be carried out. Snowfall and low temperatures during the winter months leave small windows before and after the monsoon during which patching and resealing works can be carried out.

Asphalt works are carried out using two arrangements. Larger contractors have mixing plants and paving equipment. Smaller contractors engaged in surfacing works often mix their own asphalt on site. On rural roads in mountainous terrain, there is not sufficient space for effective use of paving equipment since it requires the closure of the road during the works. Therefore, a majority of resealing works on rural roads is instead carried out by manual labour. It takes roughly 12 workdays to reseal a one kilometre road section using manual labour as compared to three days when relying on a paver.

The manual work methods, combined with appropriate packaging of works, allow for a good participation of Class C and D contractors in both routine and periodic maintenance works. Since the local construction industry is dominated by smaller firms, these management arrangements allow for an effective utilisation of the capacity available and ensure that the necessary surfacing works take place during the short periods when it is possible.

The configuration of private contractors may vary from one place to another. Some regions have a good supply of small and large contractors, while in other places there is a shortage of large firms. In more remote areas of the country there may be a shortage of contractors altogether.

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<sup>18</sup>An exception to this practice is when long-term performance contracts are being used. Such contracts can be all-inclusive leaving the entire maintenance responsibility with the contractor for a period of up to 10 years. Although there is a growing use of such arrangements on highways, most rural road maintenance contracts tend to focus on routine, periodic or emergency works.

The availability of contracting firms needs to be carefully considered when organising road maintenance.

In areas with a shortage of large or medium sized firms, works need to be packaged in a manner that allows smaller firms to implement works. Most routine maintenance works can be organised so that the smaller firms can participate by packaging contracts into sizes that do not exceed their financial capacity. Routine maintenance works normally consist of limited volumes of works. Remaining within the financial limits for which smaller firms are certified, they can still take on large enough road sections of routine maintenance.

Periodic maintenance can also be organised in appropriate packages that allow the participation of small and medium sized contractors. Such arrangements provide a viable approach where there are limited number of large contracting firms.

Some places have a good supply of large-scale contractors in possession of sophisticated road construction equipment such as paving machines, crushers and mixing plants. When planning a rural road maintenance programme in these places, it is important to make efficient use of such private sector capacity. In order to attract larger firms, contracts need to be organised in sufficiently large packages making it worthwhile to mobilise their equipment.

### Large contractors in Punjab

The Punjab has a highly developed construction industry. There are more than 100 hot-asphalt mixing plants in the state. The same contractors are also well equipped with sophisticated crushers, paving machines, large fleets of trucks, excavators and heavy compaction equipment.

Both road construction and maintenance works are carried out relying on these contractors, all of which manufacture their own asphalt products. These firms carry out both patching works as well as major resurfacing works.



These firms only take interest in the works when contracts are of a certain size.

While larger contractors are more interested in works for which they can utilise their heavy equipment, it is still important that all necessary maintenance activities are carried out – including the works best carried out using manual labour such as many of the off-carriageway activities. Large contractors are mainly interested in the pavement and surfacing works. The use of smaller contractors may be more appropriate to take care of activities requiring less equipment and more labour inputs. One option may therefore be to split works between off-carriageway maintenance and surfacing works.

**Encouraging larger contractors to nominate subcontractor to undertake routine maintenance during Defects Liability Period under PMGSY**

The PMGSY places great importance to securing adequate maintenance on roads built under this programme. For this reason the construction contracts include a 5-year defects liability period during which the contractors are obliged to maintain the completed roads. There is however a growing concern in terms of the poor commitment shown by many of these contractors to honour their maintenance obligations during the defects liability period. Poor performance during the DLP results in a significant routine maintenance backlog when ideally the roads should have been in a perfect condition. Secondly, it also advances the need for periodic maintenance.

Since several states are struggling with this issue, there seems to be a demand for some form of proactive measures to address the problem. While stronger enforcement is the obvious first hand measure, experience show that this is not always effective. One approach could be to insist that the contractors nominate a smaller local sub-contractor for the maintenance works during the DLP at the time of submitting their bids.

Some remote regions experience a shortage of contractors altogether. In order to attract construction firms from far away, contracts need to be of a certain size to justify the mobilisation costs. When contractors carry out works far away from their base station, there is a need for larger site camps. In remote areas, there is also a need for larger material depots since supply lines are longer. Smaller firms may be reluctant to take on such operations, and therefore the contracts need to be packaged into large enough sizes to attract large contractors who are willing to mobilise

over large distances. Although equipment and materials need to be imported, it may still be possible to recruit some of the labour from the villages in the vicinity of the road works sites.

Special considerations need to be taken in Integrated Action Plan (IAP) areas. Contractors from outside may have difficulties in operating in regions with insurgency activities. Local firms may however still be able and prepared to carry out works in such areas. In such areas, it is important that the works are organised in appropriate size packages that match the capacity of local firms.

#### **7.4 Common forms of contracts**

The nature of road maintenance sets some specific demands to the contracting arrangements. As opposed to most other types of civil works, road maintenance is often characterised by limited volumes of work at many locations across a large geographical area. Roads require more frequent maintenance and normally involve larger inputs as compared to other infrastructure. Furthermore, many activities are repetitive and are required several times a year.

A lot of time and energy has been spent on finding the optimal contracting arrangements for road maintenance and in particular routine maintenance. In order to secure preventive maintenance at its optimal levels, there needs to be a management system in place where the road network is attended to on a continuous basis thereby identifying damages at an early stage and thus allowing remedial action to take place quickly before more serious damage is caused to the roads. At the same time, it is important that contracting arrangements are streamlined to avoid that bureaucratic procedures overburden the staff in charge of managing the works.

Contracts form the legal agreement between two parties for procurement of works, goods or services. A civil works contract relates to the construction or improvement of some form of infrastructure. The size, complexity and cost of such work may vary widely. All contracts need to be legally valid and meet certain basic requirements to effectively



serve their purpose. With care, they can be written to cover the essential issues in appropriate detail according to the size and complexity of the works.

Government agencies usually rely on standard documents when preparing a public works contract. These documents form part of the government procurement regulations and as such must be adhered to. Making use of standardised documents, simplifies contracts management. As the same procedures are applied again and again, contractors are familiar with the prevailing regulations and conditions applied in the contracts.

### BoQ contracts

The most common form of engaging a contractor for a civil works project is to enter into a so-called “*ad-measure*” contract. This is basically a contract in which works are split up into a comprehensive list of work activities. The amount or volume of works under each of the activities needs to be carefully estimated and entered into a *Bill of Quantities*. Payment of works in a BoQ contract is based on unit rates agreed for each of the work activities and the contractor is at any given time paid only for the volume of completed works.

When road works are awarded to private contractors, the responsible technical agency enters into an agreement with a construction firm using standard contract documents.

Standard civil works contracts are designed to cater for a certain size of works. The larger and more complicated projects use more comprehensive documents. Smaller works contracts, such as the ones issued for routine road maintenance works, do not need the same level of sophistication and therefore contain less clauses and regulations. Experience shows that the smallest jobs can be managed using simplified documents, thereby reducing the time necessary for contract preparation. Still, the contract would define the type and amount of works to be carried out and linking payment to the progress of work.

Periodic maintenance of rural roads involves works of a certain volume and requires similar equipment and technical skills as when carrying out

road construction and rehabilitation works. For this reason, it is logical to use similar contract documents and procedures when engaging contractors for periodic maintenance works.

### **Petty contracts**

The traditional concept of contracting presumes that the client engages established construction firms, already registered as formal business entities and classified to carry out a certain size and type of works. Petty contracting allows contracts to be awarded to small business entities that are not formally registered as commercial firms.

Engaging petty contractors has proven to be an effective arrangement for smaller simple works dispersed over a large geographical area. Due to the limited size of the contracts, they can be let through direct selection (with limited competition), applying standardised unit rates and simplified contract documents.

When dealing with activities such as off-carriageway maintenance, the volume of works and contract amounts are much smaller, and really do not justify the use of the comprehensive contracts intended for larger civil works projects. Due to the limited size of these contracts, a simplified system can be applied.

Equally, the process of recruiting the contractors can be simplified. Instead of carrying out a full tendering process, the smaller routine maintenance works can be awarded through direct selection and negotiated prices.

### **Community contracting**

Community contracting has become a popular arrangement for minor works that are targeted towards a limited group of beneficiaries such as a village or a particular neighbourhood in an urban setting. It is an approach often championed by development agencies in order to secure a high level of local participation by the end users in all stages of the project from conception, planning to works implementation.

A common feature in community contracting is that there are normally no formal contracting firms involved in the works. Instead, the role of the contractor is replaced by the community, which takes charge of the works, relying on local labour and individuals who possess the necessary trade skills. In some instances, these groups are later recognised as a "contractor" and also utilised during the maintenance and operation phase of a project.

The client is often the same group of people which have a common interest, often identified as the end users. These groups normally have no prior experience in the world of contracting and may need considerable external technical and managerial support in order to implement the works. Community contracting can also be used for works under the management of a technical agency, such as maintenance of rural roads.

While acknowledging the limited technical skills and capacity of local communities operating as a contractor, there is still a need to follow the basic concepts of contracting. This includes establishing a contract agreement in which the works are properly quantified and priced. Equally, this arrangement also requires clearly defined procedures for supervision, measurement and payment of works – similar to conventional contracting of civil works.

A key prerequisite for this form of local involvement in the implementation of maintenance works is that there is a demand for employment in the local communities. It needs to be acknowledged that some rural areas have a labour shortage and in such places there will be limited interest in this type of maintenance arrangements. On the other hand, employment generation often forms an essential part of many rural development programmes. In areas where there is a shortage of jobs or a significant degree of under-employment, there is considerable scope for using community contracting – in particular for off-carriageway routine maintenance works.

### **Performance Based Contracts**

Performance base maintenance contracts have in recent years become an increasingly popular approach to road maintenance. The basic principle is to define a desired performance standard to which the road needs to be

maintained during a certain period of time instead of specifying a contract based on quantified volumes of work. The duration of the contracts can span from several months, i.e. throughout a rainy season, to say five years.

The contracts are awarded to established road contractors who in turn may sublet some of the works to smaller contractors, operating in the area where the road is located. Alternatively, the road authorities may choose to let performance contracts directly to smaller local contractors. Refer para 7.8 for more details.

### **Retainer contracts**

Retainer contracts with an agreed schedule of rates are sometimes used for establishing a standby arrangement for dealing with emergency maintenance works. Incidences such as major landslides and washouts can render roads impassable and therefore require immediate action in order to restore access as well as limiting the extent of damages. When serious damage takes place as a result of freak weather, there is a need to quickly mobilise resources to reopen the road. In the past, force account units in the public works departments took care of emergency works. In recent years, these units have often been disbanded and the agencies totally rely on private contractors to carry out maintenance.

In such instances, it may take too long time to secure agreements with contractors through the standard tendering process. Instead, the technical agencies can call for tenders on work activities that are commonly required in order to deal with emergency situations. These tenders essentially consist of priced unit rates for the activities normally required in order to repair road sections that has become impassable as a result of sudden severe damages. Retainer contracts are only utilised when an emergency occurs and are normally organised once a year, preferably in advance of the season during which major damages are likely to occur.

When a major incidence has occurred, the road agency can then quickly mobilise a contractor who have already submitted unit prices for emergency works. Technical staff from the road agency then carries out a rapid assessment of the works required and estimate the quantities of

work. The total cost of works is then calculated on the basis of these quantities together with the already agreed unit prices.

## 7.5 Preparing contracts

Since routine maintenance consists of smaller works, it does not require the same extensive contract documentation. Routine maintenance is best organised in small contract packages allowing for the involvement of local small-scale contracting firms. With an extensive network to cover, this implies that a large number of contracts need to be processed. Considering the simple nature of the works and the limited risks involved, there is scope for simplifying and reducing the amount of contract documentation.

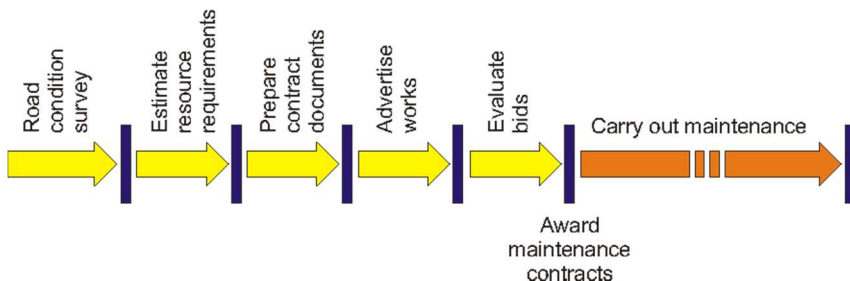
Depending on the chosen implementation arrangements, the procedures and documentation should be adapted to the specific needs of the works. The contracting arrangements for routine maintenance, organised through smaller contract packages can therefore apply simplified procedures in order to streamline management and supervision. If using a performance-based system, the Bill of Quantities is replaced with an activity schedule with the corresponding performance indicators. Such contracts also need to reflect the fact that they are time bound rather than based on specified quantities of work.

Although contracts may be simplified for smaller works, they still need to include the core elements constituting a civil works contract, being:

- contract agreement,
- general conditions of contract,
- work plan, and
- bill of quantities and payment arrangements

The preparation and management of maintenance contracts is the responsibility of the appropriate units of the road agencies. Before contracts are tendered, all estimates of quantities, task rates and unit rates should be verified and checked.

Once the estimates have been found in good order, the process of tendering works can take place. It is important that a time schedule is prepared for the entire process of contracts preparation and award, thus ensuring that the works are carried out at the correct time and that the necessary tools and material are available before commencing work.



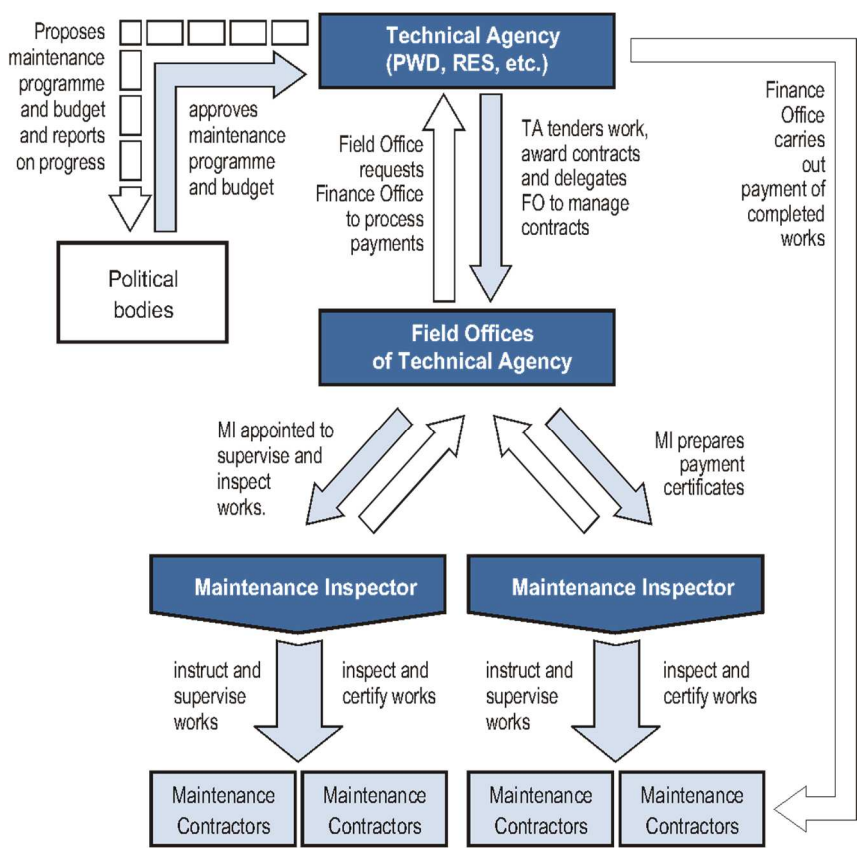
Routine maintenance contracts are usually awarded on either an annual basis or several times a year. In order for works to be carried out in a timely manner, it is important that the contracts preparation and tendering process do not take too much time, thereby jeopardising the optimal timing of works. It is important the timelines for these preparatory activities are such that the work contracts are awarded and the execution of the work synchronizes with the commencement of the working season of the financial year that the budget pertains to.

## 7.6 Contracts management

Works carried out by private contractors require that the technical agency is proficient, which can prepare and administer the works contracts in a timely manner. Appropriate management procedures therefore need to be established with clear directives and responsibilities in regard to how and by whom contracts are administered.

The figure below describes a flowchart of events during the implementation of road maintenance works and how various stakeholders are involved in the different aspects of management.

Maintenance works would ideally be directed by an overall management plan for the road network which is sanctioned by a competent authority. This plan would be based on the performance of the road network and regular condition assessments. This plan would include details on the roads to be covered by the maintenance programme and which ones are placed in the construction programme. The plan is prepared by the relevant technical agency, and its contents usually need formal approval before budgets are released.



Requests for infrastructure improvements are voiced in the local Panchayati raj bodies and development committees, and when approved forms part of a local development plan. Road maintenance however needs to be clearly distinguished from this process as it forms part of the recurrent budget required to protect already existing infrastructure assets. The appropriate oversight bodies would in this case focus on the effectiveness of the maintenance provided in terms of safeguarding earlier investments in infrastructure development.

Once the annual work programmes and budgets have been approved, the responsible technical agencies can start the detailed preparations before implementing works. Technical staff is then engaged to develop detailed plans and cost estimates, and the preparation of all works contracts. After tendering the works, contracts are awarded to the most competitive bidders.

The regular supervision of works can be carried out by a works inspector or junior engineer from the field office of the technical agencies. This personnel is in charge of monitoring the quality and progress of works and as part of this responsible for the approval and certifying of completed works.

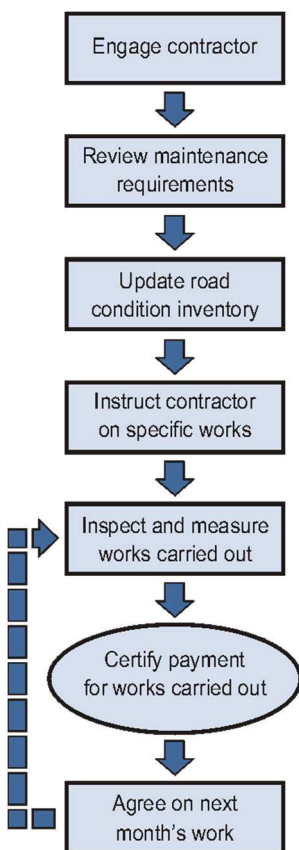
Payment certificates are issued by the maintenance inspectors, basically stating that a certain amount of work has been satisfactorily completed and is due for payment. This information is submitted to the finance section which processes payments to the contractors according to the details in the payment certificate.

The field offices need to be provided with sufficient capacity to manage all works activities taking place in their respective area of operation. Road maintenance works cover a wide geographical area and thus poses particular logistical challenges. It is therefore important that the field offices are adequately staffed with competent technical personnel and provided with sufficient logistical resources and inspection vehicles.



## 7.7 Work supervision

Once a maintenance contract has been let, it is often useful to carry out a new assessment of the works required. The original condition survey was probably carried out some time in advance of engaging a contractor and in the meantime additional defects may have developed.



At the time when the contractor mobilises, it is good practice to once again review the maintenance requirements. The original survey was primarily carried out in view of assessing the overall condition of the road and producing reasonably accurate estimates of work. Once the contractor is on site, it is important that maintenance works take place at the correct locations, applying the correct work methods. At this stage, it is therefore important to establish the full details of the work.

When issuing instructions to the contractor, it is important to record the decisions made. Planned work activities can be recorded by updating the original road condition surveys, thereby making sure that all defects including the ones developed since the original survey are adequately addressed. Using the road condition survey forms makes it easy to record the location and extent of various work activities.

The use of the survey forms makes it easy to assess whether the contractor has performed in accordance with the instructions provided during the previous inspection. In addition, these forms can be used to provide detailed records of completed works and keeping track of work that has already been certified. As such these records are also useful as

supporting documents in relation to reporting on progress and expenditure.

Road condition survey forms can also be used for assessing work carried out under performance contracts. During inspections, work that do not meet the performance requirements can be recorded in the forms, thereby providing the necessary supporting documents when calculating any deductions.

## **7.8 Defects Liability Period (DLP)**

The practice of including a lengthy defects liability period into road building contracts can be an effective means of ensuring that good workmanship is provided during the construction stage. During the defects liability period, the contractor is responsible for the routine maintenance of the road and all its components. During this period, it is important that regular inspections are carried out to monitor the performance of the road and its drainage to ensure that (i) designs are adequate and (ii) the works have been performed to required levels of quality thereby verifying that the road stands up to the normal impact of traffic and prevailing weather conditions.

In the PMGSY programme, the contractors need to maintain the road for a period of five years after the completion of construction works. This practice seeks to encourage contractors to place more importance to the quality of the initial construction works, thereby minimising failures and defects resulting from poor workmanship. This practice of extended defects liability periods is now also being used in other rural road building programmes as it is recognised to have a positive impact on the quality of the construction works.

Although the contractor is responsible for the routine maintenance during the defects liability period, it is important to differentiate between the regular maintenance works and such works resulting from damages due to poor design or exceptional circumstances.

In hilly terrain, it is expected that the contractor keeps drains and water crossings clear from silt and other debris. There are however limitations to this responsibility. When unforeseen damages take place, such as

major landslides or slips, it is important to acknowledge this as incidences that were not anticipated when awarding the contract. Such repair works are beyond the scope of the contract. The repair of such damages and the additional preventive measures required to stop future similar incidents need to be financed from other funding sources. In places with a significant risk of unforeseen damages, it may be useful to include specific contingencies in the contract for such purposes.

## 7.9 Performance contracting

Performance contracting has become a common approach for organising routine maintenance. The basic principle behind this approach is to reduce the management burden of the implementing agency, leaving most of the upkeep and inspection works with the contractor. Rather than measuring quantities of work outputs, the payment of completed works is based on a set of clearly defined performance indicators.

For routine maintenance works, the performance indicators would essentially prescribe that the drainage system would be clear of debris, silt and any scouring, the road surface is free from any potholes, that grass and bush outside the carriageway is kept short and that all road furniture is in good order. A common set of requirements for typical routine maintenance works is presented in the table below.

The main advantage of performance-based contracting is that contracts can be awarded for a period of 3 to 5 years as opposed to output based maintenance contracts in which the duration is often only 3 to 6 months. The longer contract durations means that the road agencies can reduce the number of tenders required to maintain an extensive network. There are however some prerequisites for this to be successful and competitive to other contracting arrangements:

- Actual costs of maintenance should be well known to the client agency. The costs of maintenance vary considerably depending on climatic and geographical conditions and are also influenced by the quality of the initial construction works and the degree to which the road has already deteriorated;

- The road should be in a good and maintainable condition, not requiring any major rehabilitation works;
- The quality of the road should be well known to both parties, i.e. the contracting firms and the technical agency, thereby avoiding any major unforeseen works;
- Both road agencies and contractors should be experienced in carrying out road maintenance works. Contractors new to this type of work will have great difficulty in preparing reliable cost estimates for the envisaged works.

Performance-based arrangements can also be combined with conventional item rate works. This implies that activities which can be easily predicted in advance in terms of quantities and costs are specified on the basis of performance criteria while more substantial works which is more difficult to predict to a reasonable level of accuracy is measured and paid on the basis of actual quantities of work.

This combined approach has also been used successfully on roads with a significant maintenance backlog in which the initial work to reinstate the road into a good condition is organised on the basis of measured work quantities. Once the road is reinstated into a good condition, the contractor is expected to maintain it in such condition based on performance criteria instead of measured work outputs.

Performance based contracting for routine maintenance is being used on rural roads in several states in India. The table below shows the standard activities carried out on bitumen-surfaced roads in Madhya Pradesh using this approach.<sup>19</sup> The weightages proposed here for various activities may require review to make the monitoring easy and duly addressing the concerns of the contractors.

Payment of works is approved only when a substantial part of the activities meets the prescribed performance requirements. As shown in the same table, each of the work activities is allocated an index thereby indicating its importance. These indices form the basis for payment.

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<sup>19</sup> A similar system has been developed in Jharkhand, as well as being introduced in several other states.

When summing up the indices for the fully completed activities, payment is only approved if it reaches a defined threshold, for example more than 80 percent of the total possible is achieved.<sup>20</sup>

The indices mentioned above will to a certain extent follow the costs of the various work activities. It is however important to devise a payment system that ensures that certain priority activities is given sufficient attention. Clearing drains and culverts is a good example of a priority activity during the rainy season. Clearly, the system would need to ensure that payments during this period are only approved if the drainage system is in good order. Equally, in hilly terrain with higher rainfall, it may be useful to give drainage related activities a higher rating as compared to roads located in flat and dry areas. Weightage should also be given to maintenance of breast walls, retaining walls and safety related measures.

A similar table can also be devised for WBM and gravel roads, in which terrain and weather conditions are given due consideration.

Since works are assessed solely on the basis of prescribed performance criteria, these indicators of success need to be carefully defined. In Madhya Pradesh, the performance requirements are defined by using functional standards found in the standard work specifications.

A similar system is actually in place during the 5-year defects liability period which forms part of the standard construction contracts under the PMGSY. During this maintenance period, the contractors are responsible for the same routine maintenance activities as mentioned in the table below.<sup>21</sup>

When applying this system, it is important to keep track of the actual costs of using this approach as compared to a conventional output based

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<sup>20</sup> The threshold of 80 percent is the current practice in Madhya Pradesh. This threshold can be modified depending on how the individual activities are measured as completed or not.

<sup>21</sup> The practice of extended defects liability periods on road construction contracts during which the contractor is responsible for the maintenance is becoming a common practice in many road works programmes and not only the PMGSY.

Routine maintenance activities - frequency and performance index		
Name of Item/Activity	Frequency of operations	Performance Index
1 Restoration of rain cuts and dressing of berms as per clause 1902 of the Specifications.	Once generally after rains or as and when required.	10
2 Making up of shoulders as per clause 1903 of the Specifications	As and when required	20
3 Maintenance of bituminous surface road and/or gravel road and/or WBM road including filling potholes and patch repairs etc. as per clause 1904 and 1906 of the Specifications.	As and when required	50
4 Maintenance of drains as per clause 1907 of the Specifications	Twice (in case of hill roads as and when required)	3
5 Maintenance of culverts and causeways as per clause 1908 and 1909 of the Specifications.	Twice (in case of hill roads as and when required)	5
6 Maintenance of guardrails and parapet rails as per clause 1911 of the Specifications.	Maintenance as and when required. Repairing once a year.	
7 Maintenance of road signs as per clause 1910 of the Specifications.	Maintenance as and when required. Repairing once every two years.	2
8 Maintenance of 200 m and kilometre stones as per clause 1912 of the Specifications.	Maintenance as and when required. Repairing once a year.	2
9 Cutting of branches of trees, shrubs and trimming of grass and weeds etc. as per clause 1914 of the Specifications.	Once generally after rains (in case of areas having rainfall more than 1500 mm per year, as and when required)	3
10 White washing parapets of cross-drainage works.	Once a year.	2
11 White washing guard stones.	Twice a year.	
12 Re-Fixing displaced guard stones.	Once a year.	
13 Repair of old joints sealant (CC joints) as per Specifications.	Maintenance as and when required.	3
<b>Total</b>		100
<b>Note:</b> No payment is made if the contractor achieves less than 80 points on above scale, for the period under consideration. Proportionate payment is made if achieving more than 80 points.		

system of contracting maintenance. A performance based contract places the risk of unforeseen works on the contractor. It is therefore tempting for contractors to increase their provisions for unforeseen works when submitting their tenders. In comparison, in item rate contracts most unforeseen works would be the risk of the client, since payments are based on the actual quantities of work performed. This implies that before tenders are announced, the road agency needs to carry out a detailed survey of the roads to establish reliable estimates of the envisaged works. In other words, there is still a need to prepare an Engineer's Estimate when using this contracting arrangement.

### **Concluding remarks**

Any particular choice of contracting arrangements will not provide any magic solution to the maintenance challenges. In order to reach a system in which preventive and timely maintenance is provided to the rural road network, there is a need for political will, dedicated management, appropriate systems and procedures, skilled staff and of course sufficient funding. These are the prerequisites for any successful civil works programme and it also applies to road maintenance.

Building up an effective maintenance programme can be a daunting task where there is a lacking system in place. It needs dedicated champions at all levels of the management structure, both at policy level and out in the districts where works take place. During the last 20 years, significant improvements have taken place in terms of rural connectivity. A similar commitment, effort and management capacity are now required in the field of maintenance in order to sustain the benefits of access to rural communities.





# Appendix 1

## Reference literature

Situation Analysis Report for World Bank funded Seven States, PMGSY Rural Roads Project, India, ILO New Delhi, July 2014

Financial Tracking Study on Rural Road Maintenance, ILO New Delhi, March 2014

Basic Road Statistics of India 2011-12, Ministry of Road Transport and Highways, New Delhi, December 2013

Rural Road Development Plan: Vision 2025, Ministry of Rural Development, New Delhi, 2007

Rural Road Maintenance, Sustaining the Benefits of Improved Access, Donnges, Edmonds and Johannessen, ILO Bangkok 2007

Financing of Road Maintenance in Sub-Saharan Africa - Reforms and progress towards second generation road funds, Sub-Saharan Africa Transport Policy Program, Benmaamar, World Bank, 2006

Pradhan Mantri Gram Sadak Yojana (PMGSY) Operations Manual, National Rural Roads Development Agency, Ministry of Rural Development, New Delhi 2005

Situation Analysis of Rural Road Maintenance in Madhya Pradesh, Volume I: Strategy Elements and Options for Reforms, ILO Bangkok 2005

Situation Analysis of Rural Road Maintenance in Madhya Pradesh, Volume II: Policy, Institutional and Financial Aspects, ILO Bangkok 2005

Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, Ministry of Road Transport and Highways, Indian Road Congress, 2004

MORD Specifications for Rural Roads, Indian Road Congress, 2004

Building Local Government Capacity for Rural Infrastructure Works, Edmonds and Johannessen, ILO Bangkok, 2003

Road maintenance management for district engineers, Overseas Road Note 1, TRL 2003

Rural Roads Manual, Indian Roads Congress, New Delhi 2002

Impact Assessment of Pradhan Mantri Gram Sadak Yojana (PMGSY) in the States of Assam, Himachal Pradesh, Madhya Pradesh, Mizoram, Orissa, Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal, Ministry of Rural Development (Monitoring Division) New Delhi

Hill Road Manual, Indian Road Congress, New Delhi 1998

Rural Road Maintenance Management, Ministry of Local Government, Cambodia 1998

International Road Maintenance Handbooks, PIARC, Overseas Development Agency 1994

Contracts for Road Maintenance Works, Agreements for Works by Direct Labour, SSATP, World Bank 1991