

# PUBLIC WORKS DEPARTMENT

Government of Uttar Pradesh, India

## UTTAR PRADESH STATE ROADS PROJECT Under IBRD Loan No. 4684-IN

### Technical Assistance for Implementation of Institutional Reforms in the Road Sector of Uttar Pradesh

#### REVIEW REPORT ON IMPLEMENTATION OF UPGRADED MAINTENANCE PRACTICES AND STANDARDS FOR CORE NETWORK (FINAL)

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## Glossary

ADB	Asian Development Bank	ILO	International Labour Organisation
ADT	Average Daily Traffic	IRI	International Roughness Index
AE	Assistant Engineer	JE	Junior Engineer
BMS	Bridge Management System	MDR	Major District Roads
BOOT	Build Own Operate Transfer	MLA	Member of Legislative Assembly
BOT	Build Operate Transfer	MOST	Ministry of Surface Transport
BSSL	Below Single Standard Lane	MoSRTTH	Ministry of Shipping, Road Transport & Highways
CBO	Community Based Organisation	MoRTH	Ministry of Road Transport and Highways
CBR	California Bearing Ratio	MoEF	Ministry of Environment and Forest
CE	Chief Engineer	M&E	Monitoring and Evaluation
CEO	Chief Executive Officer	MIS	Management Information System
CRF	Central Road Fund	MSS	Mixed Seal Surface
CRRRI	Central Road Research Institute	NABARD	National Bank of Agricultural and Rural Development
CSR	Civil Service Reforms	NITHE	National Institute for Training of Highway Engineers
CVD	Commercial Vehicles per day	NH	National Highway
CV	Commercial Vehicle	NHAI	National Highways Authority of India
DAO	Divisional Account Officer	NOIDA	New Okhla Industrial Development Authority
DASP	Diversified Agriculture Support Program	ODR	Other District Road
DBC	Dense Bituminous Concrete	OD	Origin and Destination
DEE	Deputy Executive Director	O&M	Operation and Maintenance
DPR	Detailed Project Report	PAC	Public Accounts Committee
DRDA	District Rural Development Agency	PCC	Project Coordinating Consultant
EC	Executive Committee	PCI	Pavement Condition Index
EE	Executive Engineer	PCU	Passenger Car – equivalent Unit
E-in-C	Engineer in Chief	PET	Terephtalic Ester Polyethylene
GC	Governing Council	PICUP	Pradeshya Industrial & Investment Corporation of UP
HDM4	Highway Development and Management System	PIARC	Permanent International Association of Road Congress
GIS	Geographic Information System	PMS	Pavement Management System
GPS	Global Positioning System	PPP	Public Private Partnership
GO	Government Order	PP	Polypropylene
GOI	Government of India	PRI	Panchayat Raj Institution
GoUP	Government of Uttar Pradesh	PSP	Private Sector Participation
GSDP	Gross State Domestic Product	PVA	Polyvinyl Alcohol
HGV	Heavy Goods Vehicle	PWD	Publics Works Department
HQ	Head Quarter	RAP	Resettlement Action Plan
HR	Human Resource	RES	Rural Engineering Services
HRD	Human Resource Development	RIDF	Rural Infrastructure Development Fund
HRM	Human Resource Management	RMMS	Road Maintenance Management System
IBRD	International Bank for Reconstruction and Development	ROMDAS	Roughness Measurement and Data Acquisition System
IDS	Institutional Development Strategy	RSPEU	Road Safety Planning and Engineering Unit
IDSP	Institutional Development And Strengthening Plan	RSC	Road Safety Cell
IRC	Indian Road Congress	R&R	Resettlement and Rehabilitation
IT	Information Technology	SDBC	Semi Dense Bituminous Concrete
ISAP	Institutional Strengthening Action Plan	SDL	Standard Double Lane

SE	Superintending Engineer
SH	State Highway
SHA	State Highway Authority
SML	Standard Multi Lane
SO	Section Officer
SPV	Special Purpose Vehicle
SRF	State Road Fund
SRP-II	State Road Project-II
SRB	State Road Safety Board
SRSC	State Road Safety Council
SRSF	State Road Safety Fund
SRSC	State Road Safety Council
SRSF	State Road Safety Fund
SSL	Standard Single Lane
MIS	Management Information System
TA	Technical Assistance
ToR	Terms of Reference
UP	Uttar Pradesh
UPRNN	Uttar Pradesh Rajkiya Nirman Nigam
UPSBC	Uttar Pradesh State Bridge Corporation
UPSIDC	Uttar Pradesh State Industrial Development Corporation
UPSRTC	Uttar Pradesh State Road Transport Corporation
UPSRP	Uttar Pradesh State Road Project
UPSHA	Uttar Pradesh State Highway Authority
UNDP	United Nations Development Programme
VOC	Vehicle Operating Cost
VR	Village Roads
WB	World Bank
WBM	Water Bound Macadam

## 1. INTRODUCTION

### 1.1 BACKGROUND

The IDS Consultants (TCE) made the following key recommendations regarding road maintenance under up PWD:

*“Maintenance process should be strengthened by adopting a systematic approach to decision making. This can be done through application of techno-economic and financial criteria, setting consistent standards, adopting cost effective technologies, effective allocation of resources and periodic review of policies, standards and measuring the effectiveness of the programme.”*

Based on these recommendations the GoUP included ‘Strengthening Road Maintenance Planning and Management’ as one of the objectives of the technical assistance under implementation of institutional reforms in the road sector of Uttar Pradesh. In this context GoUP targeted the following action milestones under the TA Consultancy services.

1. Revise UP road classifications and maintenance criteria for core network and other categories.
2. Establish Road Maintenance Management System (RMMS) featuring rational prioritization on techno-economic criteria and apply to core network maintenance management.
3. Implement upgraded maintenance practices and standards for core network.

Report No. 44 is presented against the aforesaid background and action milestone number 3 i.e. Implement upgraded maintenance practices and standards for core network.

### 1.2 ACTION PLAN AND PURPOSE

In order to upgrade the maintenance practices and standards for UP core road network the following methodology has been followed:

1. Overview of road maintenance issues
2. Review road management /maintenance practices followed in UP PWD, GOI and other states of India.
3. Identify areas for improvement.
4. Suggest upgraded practices and standards for maintenance of core network roads.

The purpose of this Report is to suggest needful guidelines in the process of implementing upgraded maintenance practices and standards for UP core road network. The actual task of implementing these upgraded maintenance practices and standards shall be performed by the UP PWD.

## 2. ROAD MAINTENANCE ISSUES

The basic aim of this report is to implement upgraded maintenance practices on the core road network under the jurisdiction of UP PWD. To achieve this aim it is necessary to set out the basics of maintenance and its requirements and make recommendations for upgrading maintenance practices.

### 2.1 DEFINITION

Road maintenance includes all those works, or activities, which are performed to maintain the pavement, shoulders, and other facilities provided for road users, as nearly as possible in their constructed conditions under normal traffic loading and forces of nature. Maintenance is essential to get optimum service from the pavement structure during its life. Moreover, to provide efficient movement of all modes of traffic it is essential to maintain all elements of the road pavement and rights of way at the highest reasonable level of safety.

All elements of the road pavement require maintenance as they are subjected to traffic and environmental effects. Maintenance helps in preserving the pavement surface, shoulders, drainage, and road furniture, thus preventing untimely rehabilitation. Maintenance requirements are dependent on design standards, traffic loading, terrain, soil type, etc. By definition maintenance preserves an asset to an acceptable operating and safety standards.

### 2.2 CATEGORIES OF MAINTENANCE

The various categories of road maintenance are listed below but described in greater detail in Section 2.5.3:

Routine Maintenance - day to day repair of minor defects in existing facilities that need to be done quickly to arrest further deterioration and to ensure the safety of road users.

Periodic maintenance - regular long-term maintenance (normally programmed) designed to restore the integrity of existing facilities, prolong their service life, and to ensure the safety of road users.

Emergency maintenance - covers those situations which call for a rapid response to restore the road pavement, to keep it open and to ensure the safety of the road user.

Rehabilitation - covers those activities that restore, or increase the structural strength of the road pavement to extend its life and safety of the road user. It does not generally require any removal of the existing pavement.

Reconstruction and Upgrading - includes those activities which restore, and generally improve, the structural and other aspects of the existing facility.

## 2.3 IMPORTANCE OF ROAD MAINTENANCE

Road Maintenance is an important activity in any Highway Authority or Government Public Works Department. Maintenance must be undertaken regularly since postponing road maintenance results in increased costs. The basic objectives of road maintenance are protection of the asset, maintenance of network capacity, continuing or improved road safety, reduced vehicle operating costs, and environmental protection.

Maintenance management is part of a comprehensive structured approach to whole life management of assets as tools for effective service delivery with a focus on community benefits. The aim of a maintenance strategy for roads is to minimize life cycle costs for all road components consistent with achieving a specified standard of performance. Proper Road maintenance contributes to reliable transport at reduced cost, as there is a direct link between road condition and vehicle operating costs. An improperly maintained road can also represent an increased safety hazard to the user, leading to more accidents, with their associated human and property costs.

## 2.4 OBJECTIVES OF ROAD MAINTENANCE

Road Maintenance operations incorporate the multiple goals of environmental protection, safety and structural integrity of the road pavement system. The basic objectives of road maintenance are to maintain and operate the highway system to:

- Preserve the existing road asset and user safety, by the timely repair of defects so as to maintain the road in usable condition at all times and at the least cost to the Government and the road user.
- Preserve the aesthetics and compatibility of the highway system with the environment.
- Provide comfort, convenience and safety to the road users and general public.
- Maintain a highway system that provides the safest practicable environment for road users and workers.
- Establish and maintain procedures for maintenance and emergency operations that provide for safe highway and transit operating conditions during these activities.
- Reduce the deaths, injuries and damage due to accidents on highways.

The aim of any maintenance strategy is to minimize life cycle costs for all road components consistent with achieving a specified standard of performance.

## 2.5 REQUIREMENTS OF ROAD MAINTENANCE

Road maintenance services should essentially cover the following:

### 2.5.1 Maintenance programming and planning

One of the essential requirements for systematic and efficient maintenance of the road network is programming and planning. The manual should be able to provide guidelines on the programming and planning aspects of road maintenance. The PWD must develop and maintain



a programme for road maintenance for the entire road network under their jurisdiction. The programme should be regularly evaluated and suitably modified to promote the maintenance of roads and highways in the best practical condition. This programme should comprise of the following activities:

- Identify needs
- Establish priorities
- Establish procedures

Identify Needs: The identification of needs is the first stage in the development of a successful maintenance programme and is required when any portion of the road network is in sub-standard condition. Action is also required to correct any situation which is hazardous, or may become hazardous, in the near future. This may be accomplished by both regular inspection of the road network and proper analysis of accidents records.

### **(i) Inspection**

Inspection plays a major role in maintenance of the road network. Road inspections are vital as a means of keeping the pavement safe for the travelling public and to demonstrate that the PWD adopts a responsible attitude in the performance of its duties.

Inspections should be scheduled throughout the year and include careful examination of the function and physical condition of road assets and systems including pavement surface, drainage, structures, guard-rails, traffic signs, road markings, and vegetation.

Through the inspections the road condition is assessed, defects identified, intended repairs detailed and recorded, subsequent details (including quality) of actual repairs undertaken is verified and data collected during inspection used for planning future maintenance strategies. Regular inspections are an important factor for road maintenance but specific guidelines and procedures for the inspection of roads and bridges have not been established in UP PWD. It is suggested that the guidelines, procedures, standardized forms for noting down observations, quality control tests, and frequencies of inspection should be included in the maintenance manual.

### **(ii) Accident Records**

A regular programme of accidents investigations, record keeping, and analysis should be established to provide information for recommended alignment modifications and correction to maintenance requirements. Cooperation among PWD, traffic operations, and the police is required and activities of these agencies should be coordinated in accordance with approved guidelines regarding identification and surveillance of accident locations.

Inspection of the road network and analysis of accident records should be utilized to provide feedback for modification of design and construction procedures. A chapter covering this aspect should be included in the Maintenance Manual.

### 2.5.2 Establishment of priorities

The maintenance work found to be necessary by the identification programme should be prioritized. The objectives of establishing priorities for the maintenance of road network are as follows:

- Ensure that the road network provides safe, affordable and comfortable travel;
- Provide timely and cost effective preventative maintenance to maximise the safety of road users and to minimise the deterioration of the road network; and
- Restore, and possibly improve, the original road condition where economically justified.

Where maintenance budgets are inadequate, priority to achieve the above generally will be addressed in the following order:

1. emergency maintenance (safety);
2. routine maintenance; and
3. periodic maintenance

As a rule of thumb 80 percent of traffic flows over 20 percent of the road network. This core network of heavily trafficked roads should receive priority for full routine and periodic maintenance.

According to PIARC -1999, "If Money is short, and it usually is, there is one rational course of action:

- Maintain existing roads before funding new ones
- Make sure it is done today, even every day, because tomorrow, it will be much more expensive."

When it comes to road maintenance and limited budgets the strategy to adopt should be to maintain those roads which are in a reasonable condition since they will deteriorate at a faster rate than those that are already in a poor condition.

### 2.5.3 Establishment of Procedures

The Maintenance Manual developed by the PWD should provide standard procedures and methods for maintenance operations for the efficient and safe completion of required work. All maintenance work shall be conducted in accordance with the standards set out in the Maintenance Manual. The Manual should specify the methods, procedures, equipment, personnel qualifications and other aspects of work necessary to ensure successful completion of maintenance operations.

Procedures should be developed for emergency, routine and periodic operations.

### **(i) Emergency Maintenance**

This covers those situations which call for a rapid response to restore the road pavement, to keep it open and to ensure the safety of the road user. Emergency maintenance generally results from crashes, floods, or landslides. These activities include emergency works to repair landslides, and washouts that result in the road being cut or made impassable. A special contingency provision should normally be included within the maintenance budget to fund these works which, by definition, cannot be foreseen.

This type of maintenance would include the following:

- Removal of debris from crashes, cargo spillage or other causes. This activity should be conducted in accordance with the guidelines set out in the Maintenance Manual.
- Replacement of inoperative traffic control devices
- Repair or replacement of damaged highway safety components such as lighting, traffic control devices, redirection, and energy absorbing devices.
- Removal of tree limbs and branches fallen on the pavement
- Repair or correction of any situation that provides an immediate or unexpected hazard to the public.
- Assistance in any activity during emergency response operations.

### **(ii) Routine Maintenance**

This is the day to day repair of minor defects in existing facilities that need to be done quickly to arrest further deterioration and to ensure the safety of road users. Routine maintenance works are undertaken each year and are funded from the recurrent budget, and come under non-plan works. Activities can be grouped into cyclic and reactive work types. Cyclic works are those undertaken where the maintenance standards indicate the frequency at which activities should be undertaken. Examples are verge cutting and culvert cleaning, both of which are dependent on environmental effects rather than traffic levels. Reactive works are those where intervention levels, defined in the maintenance standards, are used to determine when the maintenance should be carried out. An example is patching, which is carried out in response to the appearance of cracks or potholes.

Preventive routine maintenance is largely small scale water management. Water must be removed as quickly as possible from the road surface before it softens the surface and does irreversible damage to the road bed and foundation. This requires eliminating standing water by filling potholes and ruts on level ground as well as preventing the formation of lateral and longitudinal gullies where the destructive momentum of flowing water is particularly damaging. The convexity of the surface must be restored and ditches and culverts kept clean since they can easily get blocked and divert the water back onto the road.

Routine maintenance includes operations such as:

- Cleaning and removal of debris from the pavement, shoulders, and roadside clear zones.
- Mowing and other vegetation control operations to provide a smooth recovery area and to maintain proper sight distances.
- Cleaning and inspection of gutters, ditches, and other drainage structures.
- Structural inspection and preventive maintenance on bridges and other structures.
- Cleaning, replacement, and maintenance of roadway lighting fixtures
- Replacement and maintenance of traffic control devices.
- Inspection and maintenance of emergency response communication systems and access facilities.
- Inspection and maintenance of pavement and shoulders, with particular emphasis on maintaining shoulders flush with the pavement.
- Inspection and maintenance of all highway components and safety features.
- Inspection and maintenance of pedestrian pavements, crossings, etc.

### **(iii) Periodic Maintenance**

This is regular long-term maintenance (normally programmed) designed to restore the integrity of existing facilities, prolong their service life, and to ensure the safety of road users. It includes activities undertaken at intervals of several years to preserve the structural integrity of the road, or to enable the road to carry increased axle loadings. The category normally excludes those works that change the geometry of a road by widening or realignment. Works can be grouped into works types of preventive resurfacing, overlay, and pavement reconstruction.

The application of a Road Maintenance Management System coupled with HDM 4 should be used to determine the annual maintenance budget and maintenance intervention. Funding is part of that for non-plan works.

Periodic maintenance includes the following activities which are carried out in response to measured deterioration in the road condition:

- Renewal, resurfacing or resealing of bituminous pavement (roughness and/or skid resistance measurements)
- Provision of overlay to carry increased axle loadings (traffic, Benkelman Beam deflection survey and axle load survey)

### **(iv) Rehabilitation**

This covers activities that restore, or increase, the structural strength of the road pavement to extend its life and safety of the road user. It does not generally require any removal of the existing pavement. An example of rehabilitation is where the structural strength of the pavement is increased through adding material, such as crushed stone, on top of the existing pavement and then laying a base course and wearing course on top of the crushed stone.

### **(v) Reconstruction and Upgrading**

This includes those activities which restore, and generally improve, the structural and other aspects of the existing facility. Examples of reconstruction are where the condition of the pavement has deteriorated to such an extent that the only feasible solution is to re-construct it. This type of situation should never be permitted to arise since the cost of reconstruction is some three to four times what it would have cost to maintain the road in its original condition.

It is often expedient to include minor upgrading work within a maintenance project where the work reduces future maintenance requirements, or removes a hazard. Some examples are widening the pavement around a curve, the realignment of a small length of a road, sealing gravel shoulders, replacement of an existing structure, enlarging an existing culvert, improving an intersection layout and the bituminous surfacing of a short length of gravel road.

### **(vi) Pavement Maintenance**

The primary purpose of pavement maintenance is to ensure the pavement characteristics are reasonably maintained. The agency with responsibility for maintenance of streets and highways shall establish a meaningful pavement maintenance system (including shoulders and drainage structures) for the entire system under its jurisdiction. This program should include:

- A process that monitors the serviceability of the existing streets and highways and identifies the pavement sections those are inadequate
- A systematic plan of maintenance activities designed to correct structural deficiencies and to prevent rapid deterioration
- A preservation program, with assigned priorities, designed to resurface, reconstruct, or replace pavements when they are no longer structurally serviceable

Pavement maintenance requires a substantial portion of the total maintenance budget. It is necessary to ensure highway safety, and a smooth-riding, skid-resistant surface must be provided at all times. The reduction of hydroplaning and splashing is essential for promoting safe and efficient operation during wet weather conditions. The elimination of driving discomfort, and vehicle damage caused by deteriorated pavements, provides additional economic justification for maintaining the pavement in a fully serviceable condition.

It is recognized that a comprehensive preservation program is expensive. Adequate financing is required to successfully carry out these activities. The establishment of appropriate budget priorities and careful planning can assist in developing and preparing a pavement maintenance and preservation program that will, within a reasonable number of years, bring sub-standard pavements up to the required level of serviceability and will maintain the adequacy of the entire road network.

#### **2.5.4 Technology**

An important activity under maintenance services is to finalize the appropriate remedial measures for rectification of defects/deficiencies noted during inspections. For successful implementation of maintenance activities the selection of appropriate remedial treatment and its method of application is of paramount importance. The technology selected for maintenance works should be appropriate, environmentally friendly, and cost effective. It should also be technically sound and appropriate from all considerations.

There can be several alternative technical solutions for rectifying specific defects on a particular road pavement. The Maintenance Manual should be able to give guidelines regarding the use of appropriate technology for rectification of defects /deficiencies in the pavement.

### 3. MAINTENANCE POLICIES AND PRACTICES IN OTHER INDIAN STATES

#### 3.1 GUJARAT

Norms for maintenance of roads are based on a fixed rate per kilometer. The rates adopted include the amount needed for ordinary repair and periodic repairs (known in Gujarat as current repairs and special repairs respectively). While both State Road and Bridge Divisions and Pachayat Divisions are responsible for road maintenance, the former look after maintenance of the majority of State Highways and most of the Major District Roads while the latter take care of some Major District Roads, Other District Roads and Village Roads.

Budget requirements are formulated by the Divisions taking into consideration the lengths and respective norms for the different categories of road which are then used for determining the budget estimates for the State Roads. However, the actual budget allocations depend upon the overall financial conditions and resources available for the year.

A detailed inspection of the road listing the maintenance work to be done in the following year is completed before the end of the year end by the Assistant Engineer and then at the year end by the EE/SE. By April the list of maintenance work is prepared for the following financial year, taking into account the work done up to March of the previous financial year and their financial liability spread beyond April for the following financial year.

As per 8th Financial Commission the breakdown of the total sum allocated for maintenance of roads is shown below:

Ordinary Repairs:	35%
Surface Renewals:	50%
Special repairs and minor flood damage repairs:	15%

The normal practice in Gujarat is for the maintenance allocation to be divided into only two parts, viz, 35 percent for ordinary repairs and remaining 65 percent for periodic repairs.

The normal practice for ordinary repairs is for the Engineers at various level levels to make road inspections at different intervals. Based on these inspections instructions are issued by the DEE/SO to the labour gangs. The work or tasks undertaken by the labour gangs are:

- i. Patch repairs
- ii. Pavement edge repair
- iii. Removal of excess vegetation
- iv. Repairs to shoulders
- v. Cleaning culverts and bridge openings and minor repairs
- vi. Painting of kerbs and road furniture
- vii. Traffic surveys.

Although many of the maintenance and repair works are carried out by the permanent labour gangs they are reported to be not very productive and highly costly. As a result the allocated maintenance funds may not produce the anticipated results.

Periodic maintenance works are normally carried out by qualified contractors who have the required expertise and equipment. These works are invariably carried out using material from a hot mix plant located within a reasonable haulage distance.

### **3.2 MAHARASHTRA**

As in the State Gujarat the norms for maintenance of roads in the State of Maharashtra are based on a fixed rate per kilometer. The various items of maintenance works which are required to be considered include ordinary repairs, periodic renewal, special repairs, flood damage repairs, maintenance and repair of major bridges.

The budget for ordinary repairs is made under three heads:

- i. road gangs for maintenance,
- ii. patch repairs and
- iii. side shoulder repairs.

Some maintenance work for bridges may fall under special repairs, but in need of extra attention are put under separate norms Ordinary repairs cover routine maintenance which are normally executed using the departmental labour.



## 4. REVIEW UP PWD ROAD MANAGEMENT MAINTENANCE PRACTICES

### 4.1 MAINTENANCE MANUAL OF ROADS

A revised version of UP PWD's Maintenance Manual of Roads was published in the year 1984 under the orders of the Engineer-in-Chief, UP PWD. Since then updating of this manual has not been done. However, some circulars and Government orders dealing with maintenance of roads has been issued from time to time after publication of revised manual.

The UP PWD Maintenance Manual highlights the following:

- i. The PWD maintenance practice
- ii. Approved practice as actually followed and as indicated from time to time in the circulars of Chief Engineer and also in the paper and discussions of the IRC.
- iii. Other literature updates on highway maintenance

The purpose of UP PWD maintenance manual is to set out general instructions relative to all phases of the road maintenance works handled through the PWD in order to develop uniformity of practice in securing high standard and economical type of work. Since the publication of the Maintenance Manual in 1984 there have been significant developments in technology for construction and maintenance of roads, and substantial growth of traffic. The maintenance needs have not remained static but have been continuously changing with new emerging needs and advancement of society. With these technological advances and continuously changing maintenance needs the UP PWD maintenance manual should have been updated and revised from time to time. But this has not been the case and in the present day context the manual is obsolete.

In the maintenance manual the specification aspects of the maintenance treatment have been elaborated in great detail but it fails to provide technical directions or guidelines regarding precise assessment and codification of the present road condition, diagnosis of the problem encountered, and selection of the most appropriate maintenance treatment. The manual is mostly compiled on the basis of stipulations contained in PWD manual of orders and circulars issued by senior PWD Engineers.

Important issues relating to planning, inspection, maintenance criteria and standards, intervention levels, execution of maintenance operation, quality control and documentation have been incorporated but in a very casual manner.

In particular the Maintenance Manual has the following deficiencies:

1. The manual is unable to provide proper guidelines and directions on maintenance activities.
2. It does not provide a clear understanding as to 'when', 'what' and 'how' to treat, determine priorities more objectively, allotment of the available resources where they are most needed, or formulation of a rational road maintenance programme.

3. Several circulars and Government orders issued from time to time have been appended with this manual. Some circulars and GO appended with the manual have no relevance to the maintenance aspects of roads. Drawings and sketches appended with the manual are taken from the IRC codes. The standard codes of IRC provide all such information in detail therefore repeating them here serves no purpose. Some of the circulars are pretty old and are not relevant in the present day context.
4. Specifications given in the manual for some of the items have become obsolete.

The following important maintenance areas have not been properly elaborated or addressed in the manual:

1. Maintenance planning
2. Implementation
3. Technology
4. Monitoring
5. Capacity building of local workers and productivity of gang labour

The current Maintenance Manual is out of date and not able to serve the intended purpose therefore its modification is of the utmost importance.

#### **4.2 EXISTING ROAD MAINTENANCE PRACTICES IN UP PWD**

This Section details the maintenance policies and practices as given in the Maintenance Manual (1984) and Manual of Orders Volume 1. Comments on these policies and practices are given in Section 5.

Road maintenance is mostly labour intensive. Routine maintenance is generally carried out by the Departmental labour force (Permanent road gangs). At times additional temporary labour force is also engaged on daily wages for carrying out repair and maintenance where heavy maintenance and repairs are necessary. Normally in UP PWD engaging daily wage labourers on muster roll is prohibited. Renewal and special repair works are executed by engaging contractors.

Road maintenance in UP PWD is carried out as per the guidelines stipulated under paragraph 407(a) of PWD Manual of Orders Volume-1. According to the general policy stipulated in the maintenance manual the distribution of maintenance expenditure on different components of highways is based on surface type. Recommended distribution of maintenance expenditure is shown in Table 1.

**Table 1 : Distribution of Maintenance Expenditure by Surface Type (Percentage)**

Sr. No	Item	Water Bound Macadam (WBM)	Painted	Cement Concrete
1	2	3	4	5
a	A Travelled way surface ( Patch repair work will not exceed 10% of grant)	20	70 (60+10)	75
b	Shoulders (Patries)	60	10	10
c	Drainage- Ditches, Culverts	7	3	2
d	Road side – Jungle clearance, Erosion control vegetation foot path	3	2	3
e	Traffic service Guard rail signals	2	2	2
f	Clearance of slips fallen trees and other obstruction	2	2	2
g	Bridges – Super structure, sub structure, stream bed signs	5	10	5
h	Special service: Land limitations, detours, diversion, public relation etc	1	1	1
		100	100	100

The Manual of Orders stipulates that efforts should be made to repaint 25% of the total kilometres in the Division if funds are available. However, the UP Road Development Policy 1998, stipulates the renewal cycle in terms of length for various categories of roads as indicated in Table 2.

**Table 2 : Annual Maintenance Renewal Cycle Times for Various Categories of PWD Roads**

Category of Road	Renewal Length	Remarks
National Highways	1/3 length of NH	
State Highways	1/5 length of SH,	Revised by GO as 1/4 <sup>th</sup> of SH length)
Major District Roads	1/6 length of MDR	Revised by GO as ¼ length of MDR
Other District Roads and Village Roads:	1/8 length of ODR and VR.	

Paragraph 396 to 398 of the Manual of Order Volume I refers to the preparation of maintenance programmes. According to the provisions in the Manual the annual repair estimate for the year is to be prepared and sanctioned by the Executive Engineer up to the amount of normal annual repair allotment. The annual repair estimate shall provide all foreseeable items which are necessary to keep the road in good condition. At least 20% of the grant should be earmarked for improvements. Potholes on road surface should be never left unattended.

Preparation of programmes for work gangs is mandatory according to paragraph 11.05 Section XI of the Maintenance Manual. There is provision for monthly programme, dates of visits, tasks to be performed and samples of work to be performed.

Paragraph 403 of the Manual of Order Volume-I divides repairs to road communications under two heads:

1. Annual Repairs; and
2. Special Repairs

Annual repairs consist of all foreseen repairs necessary to maintain the roads in good condition and fit for traffic. The frequency of renewals should be based on the general condition and existing thickness of the crust of metal for each section of road. Carrying out renewal treatment at fixed intervals of time is not permitted. Standard forms for annual repairs estimates are prescribed.

Special Repairs include any repairs necessitated by damages which have occurred, or anticipated, or which may be necessary, to prevent further damage. Paragraph 412 of the same manual of orders further sub-divides special repairs into the following three categories:

1. Immediate Works - those which must be carried out at once in order to keep communications open e.g. washout of a bridge or complete land – slip of a hill road. These works will be a first charge against the “special repairs” allotment and can, with the cognizance of the Chief Engineer, be taken in hand in anticipation of sanction of the estimate
2. Urgent - those that must be carried out before the next monsoon to avoid further damage and will be taken in hand on sanction of the estimate and allotment of funds.
3. Necessary - those that are desirable but which could, if funds are not available, be postponed for a year. These works will be taken in hand if funds are available after immediate and urgent works have been financed.

For identification of the type of bituminous road surface failure and their remedial measures the Pramukh Engineer (Engineer-in-Chief) issued guidelines vide circular no 1PW (Roads) /5/07 MT/DRI/Lucknow dated 24th November 1982.

To assess the requirements of periodic renewal, condition surveys should be conducted twice a year; one before and other after the monsoon period. In general the maintenance manual provides the following guidelines regarding road maintenance:

- For road maintenance repairs to large and extensive surface failures by scarifying, reshaping and adding additional materials as necessary depends on soil, climate, location, material and traffic.
- Shoulders or patries should be dressed and rammed to maintain the correct profile: if necessary soil stabilization may be done.

- Road maintenance stipulates prevention of erosion of slopes, embankment and roadside area by rounding and flattening affected areas, seeding, sowing and planting trees and vegetation.
- In hilly districts some roads have Irish bridges/causeway. Special attention to road safety is recommended: the use warning signs, lanterns and flags for signalling etc are suggested.
- Other important maintenance measures include safety services, clearing of slips, repairing of bridges etc and special services.
- Maintenance of drainage items is considered as preventive measures for safety and convenience. Routine cleaning of ditches and culverts is recommended.

### **4.3 CURRENT UP ROAD MAINTENANCE POLICY**

#### **UP Road Development Policy 1998**

In 1998 the Public Works Department formulated a Road Development Policy. The objectives regarding maintenance of roads set out in that policy document are:

- To keep the roads free of potholes and patches by continuously maintaining and repairing them.
- To maintain and modernize National Highways, State Highways, Major District Roads, Other District and Village Roads in the State.
- To arrange financial resources for the road development works
- To ensure quality in the construction and maintenance of roads
- To bring about organizational and procedural improvements in PWD.

## 5. DEFICIENCIES IN CURRENT PWD MAINTENANCE PRACTICES

### 5.1 UTTAR PRADESH

The following comments refer to the State of Uttar Pradesh and are based on the Guidelines for Maintenance Management of Primary and Secondary Urban Roads published by the Indian Roads Congress in 2004:

- The current maintenance and rehabilitation measures for pavements are only based on subjective judgement and past experience of the Highway Engineers.
- Even if the Engineer responsible for making decisions has a significant experience upon which to base and draw up the maintenance strategies, there are no available analytical tools for use by the Highway Agencies to assist in selecting the optimum strategy based upon “life cycle cost”.
- The PWD lacks an effective road management and maintenance system, so that the limited funds available for maintenance may be utilized as efficiently and effectively as possible.
- The principle causes of pavement deterioration are not investigated due to lack of data on design, construction, and maintenance aspects of the pavement.
- Because of limited resources the roads are constructed in stages. The pavements are normally designed for an initial service life of about 10 years and then later strengthened as required due to increases in traffic volumes and axle loads.
- The present procedure for budget allocation for road maintenance is based on the a percentage of the norms requirements (the percentage is getting smaller) and the excessive use of traditional (and mostly outdated) labour intensive maintenance methods that do not meet the maintenance requirements and frequently result in a waste of resources.
- The allocation of funds fails to meet 30 to 40 per cent of the annual maintenance requirement for the road network. Consequently the gap between budget requirement and what is allocated has been increasing and accumulating over the years.
- Apart from funds, weak planning, poor scheduling and monitoring of maintenance operations, inherent deficiencies in the crust thickness, and lack of attention to drainage have contributed towards the accelerated deterioration of the road network.
- Lack of proper coordination between different components of road maintenance work and different organizations.
- lack of multi-year or strategic planning leading to ineffective resource allocation and investment inefficiency;
- The specifications laid down for materials and machinery are seldom followed
- Bituminous materials/mixes are not properly designed and produced for maintenance.
- The surface is not checked and corrected for cross slope and undulations so that no levelling course is provided to make up for same.

The PWD has traditionally relied on its in-house labour force to carry out maintenance work. The present practice of executing the maintenance works departmentally has led to an anomalous situation resulting in much of the funds used for payments to labourers with very little available for materials and machinery required for maintenance. Compounding the problem, the productivity of the labourers is low.

The quality of maintenance work is poor with a lack of checking and monitoring quality control. Gangmen need to be trained in road maintenance practice.

In addition to the above there is no system in place for training PWD personnel in maintenance operations.

## 6. IDS CONSULTANTS CONCERNS AND RECOMMENDATIONS

In their Final Report dated June 2002 the IDS Consultants (TCE) identified certain key concerns regarding road maintenance process in the state and made recommendations to mitigate them.

### 6.1 KEY CONCERNS

Key Concerns identified by IDS consultants are listed below:

- Maintenance funds allocated under the non-plan account head, along with various administrative heads. This allows scope for inefficient allocation whereby the key maintenance activities are scaled down to a level of funding that is often inadequate for the necessary output.
- Lack of concern over preparation and use of well planned maintenance calendar for on-carriageway works and off-carriageway works.
- Due to financial constraints, the present thrust is on pothole filling and patching with inadequate emphasis on shoulder grading, drainage, clearance and other off-carriageway items.
- Lack of emphasis on measured physical condition of the roads with over reliance on subjective judgment and 'rule of thumb' when selecting stretches for renewal.
- Renewal and repairs of pavement undertaken using bituminous treatment and asphalt concrete without due regard to the cause of failure. Without appropriate diagnostic processes repetitive failures will inevitably occur. The current practice results in wastage of available limited resources.
- Labour intensive maintenance methods are in practice, resulting in poor quality and cost ineffectiveness; and
- PWD is using obsolete equipment resulting in poor quality of works.

### 6.2 RECOMMENDATIONS OF IDS CONSULTANTS

The IDS Consultants listed the following Key Recommendations to mitigate the identified issues;

#### 6.2.1 Maintenance Process

Maintenance process should be strengthened by adopting a systematic approach to decision making. This can be done through application of techno-economic and financial criteria, setting consistent standards, adopting cost effective technologies, effective allocation of resources and the periodic review of policies and standards to measure the effectiveness of the programme.

#### 6.2.2 Maintenance Budgeting

Sustainable, dedicated, sufficient and timely funding should be made available for maintenance related activities. The present method of maintenance funding under non-plan budgets where general administration and overhead expenses are also covered, needs to be modified.



### 6.2.3 Maintenance Operation

- The existing maintenance norms should be revised for core network, and non core road network.
- Maintenance operations for Core road network (8000 km) should be condition responsive. Renewals should be undertaken based on agreed threshold value for road roughness and other road condition parameters. Prioritization of the investment planning for the road sections should be done using standard pavement Maintenance Management Systems (MMS/PMS system) developed for the purpose.
- The non core road network and village road network should be renewed as per the PWD norms for renewal cycle and specifications.
- To this effect, there is an urgent need to prepare a renewal specification matrix for non-core road network and village road network that would guide the Department in deciding the type of renewal (DBC, SDBC, MSS or surface dressing) and its specifications, design life and thickness. The matrix would be based on traffic intensity, terrain, rainfall and category of road. While preparing this matrix, due consideration has to be given to the experience of Department Engineers in the field and analytical findings supported by field data on different types of roads in the state.
- A calendar for maintenance related activities (routine and recurrent and renewal) should be prepared and adopted. Due considerations should be given to topographical, geographical, traffic and climatic conditions, while preparing the calendar.

### 6.2.4 Introduction of new technology maintenance methods

- Procedures should be introduced to identify stretches and determine cost – effective remedial measures, devised either in-house or by external Consultants. The use of new technology, new construction materials and techniques (such as geo-textiles, soil stabilization etc.) should be promoted. To achieve this PWD needs to develop pavement management skills through training, in-house research and practices.
- Promotion of mechanical methods using new technology and equipment for pothole filling, patching, shoulder grading and renewals should be introduced in conjunction with manual labour based methods.

### 6.2.5 Quality Control

Periodic assessment of the effectiveness of maintenance activities (performance quality audit) should be introduced. This evaluation should normally be done by the PWD in-house quality unit or the involvement of an external agency (third party).

## **7. RECOMMENDATIONS FOR IMPLEMENTATION OF UPGRADED MAINTENANCE PRACTICES IN PWD**

### **7.1 RECOMMENDATIONS FOR UPGRADING MAINTENANCE PRACTICE IN PWD**

The following Sections list a series of issues which need to be addressed if maintenance practices in the PWD are to be improved. The issues are:

1. Revisions of existing Road Maintenance Manual
2. Organisational re-structuring
3. Road Maintenance Management System
4. Road maintenance budgets
5. Renewal cycle
6. Quality control of maintenance works
7. In-house maintenance
8. Out-sourcing maintenance
9. Improve range of maintenance treatments
10. Improve range of materials
11. Improve preparatory works
12. Road Safety
13. Environmental considerations
14. Establish and Implement Training Courses

### **7.2 REVISE EXISTING ROAD MAINTENANCE MANUAL**

The Road Maintenance Manual used in the PWD was developed in 1984. It is now obsolete because of the advancements in road maintenance technology with respect to both materials, and plant and equipment: it should be totally revised.

The revised manual should cover the management system and procedures for maintenance and upkeep of all roads under the control of the PWD, including procedures based on quality assurance and reporting system. It should fully appreciate the cause and treatments of all types of defects on the roads. The manual should emphasize inspections, diagnoses, and reporting to assist the PWD to develop a viable annual maintenance budget and works programme.

A maintenance manual should aim for uniformity of practices and procedures. In the revised manual uniform minimum standards and criteria for maintenance should be developed. These standards should provide basic guidance for developing and maintaining a highway system with reasonable operating characteristics and a minimum number of hazards. The maintenance manual should include maintenance programming and planning, establishment of priorities and procedures, and a Road Maintenance Management System (RMMS).

The Road Maintenance Manual would provide an analytical tool to assist the PWD Engineers in selecting the maintenance strategy based upon economics of 'life cycle costs'. All PWD personnel responsible for road maintenance must be conversant with the manual and trained in its use and application.

The revised maintenance manual should include the following main categories:

1. Organization and general details
2. Resource management
3. Laws, Rules and Regulations
4. Equipment
5. Blasting
6. Sampling and testing of materials
7. Maintenance Management system.
8. Surface maintenance
9. Drainage maintenance
10. Roadside maintenance
11. work zone safety
12. Structure maintenance
13. Emergency maintenance
14. Inspection

The main categories should be divided into sub-categories. For example surface maintenance may be sub-categorized into all such activities which are related to surface of the roadway such as:

- Pavement maintenance (Flexible, Rigid, and Gravel)
- Shoulder Maintenance
- Pavement surface cleaning
- Rock and Debris removal
- Highway structure maintenance
- Curb barrier and island maintenance
- Railway crossing maintenance

### 7.3 ORGANISATIONAL RESTRUCTURING

If the PWD is to become an effective and efficient organisation responsible for the State Road Network some organisational restructuring is essential. New Units, such as Policy and Planning, Road Maintenance Management System/GIS, MIS/IT, and Human Resource Management must be included.

The Zones must be empowered as the operational Units in the PWD with a clear mandate to carry out construction, upgrading, and maintenance works. In particular the Executive Engineers in the Divisions must be enabled and empowered to carry out these works free of interference from external pressures. All work must be undertaken in accordance with the strategic plans prepared by PWD HQ and the annual budgets provided by GoUP.

The focus must be on the development of the road network in accordance with the Road Network Master Plan. Contracts set up according to the strategic plans and works undertaken where they are managed and supervised by the PWD to ensure that they are completed on time, within budget, and to the quality/standard prescribed in the Specification.

In the PWD work load norms have been based on the yearly average budget allocation to a Division, which for a normal PWD Division is around Rs.12.00 crores. Fixing of norms based on budget allocation has its own drawbacks since it does not take into consideration the volume of work needed to accomplish the assigned tasks. It would be more appropriate if the norm of a core road Division was to be based on physical assets i.e. length of roads to be managed by a Division. It is suggested that norms should be set for performance monitoring role of PWD staff responsible for maintenance at all levels as given in Table 3.

**Table 3 : Proposed Performance Norms for Circles, Divisions, and Sub-Divisions**

Office	Officer	Length (kms) in terms of equivalent single lane	Remarks
Zone	Chief Engineer	4,000 to 5,000 kms	Average annual expenditure on all Works INR 312.5 Crore (\$M78)
Circle	Superintending Engineer	2,000 to 2,500	2 Circles under one Zone Maintenance and new construction
Division	Executive Engineer	800 to 1,200	2 to 3 Divisions under one Circle Maintenance: Routine and periodic
Sub Division	Assistant Engineer	200 to 300	3 to 4 Sub-Divisions under one Division Maintenance: Routine and periodic
Section	Junior Engineer	50 to 75	3 to 4 Sections under one Sub- Division Maintenance: Routine and periodic

Further details relating to the proposed organisation structure for the PWD Zones, Circles, and Divisions are given in Report No. 11

#### **7.4 PURCHASE A ROAD MAINTENANCE MANAGEMENT SYSTEM (RMMS)**

A road network is a valuable asset and the best way to ensure its protection, retain its availability, and minimize whole life costs is through a road maintenance management system. Such a system will store data regarding road inventory, condition surveys, traffic surveys, vehicle operating costs, types and costs of various maintenance intervention strategies. When linked with HDM 4 that system can be used to prepare annual budgets based on maintenance

prioritisation. It is in fact a decision support system which can be used to produce a maintenance budget that is sufficiently robust to withstand any questioning. When used in the correct manner the overall condition of the road network can be improved and sustained.

The benefits of such a system are as follows:

- Lower whole life costs – huge savings can be made if major interventions are correctly timed.
- Better use of available finance – planned cash flow
- Preservation of the asset.
- Better programming and prioritization of work
- Increased traffic flow because of improved condition of the road and reduced vehicle operating costs
- Fewer complaints
- Greater user satisfaction.

Major activities of an RMMS include the following:

- Collection of Data: All of the above activities need data. Major data items include highway inventory, condition, traffic, and economic data;
- Needs Assessment;
- Strategic Planning, including budgeting for new development and asset preservation;
- Development, under budget constraints, of multi-year works expenditure programs; and,

It is imperative that the PWD purchase and develop a Road Maintenance Management System as a top priority. At the time of writing this Report the PWD, through the IDS Project, is seeking expressions of interest from organisations with the capability to carry out pavement condition surveys using Roughness Measurement and Data Acquisition System (ROMDAS). What, one wonders, is the PWD planning to do with the condition data obtained should a contract be placed for this work?

For further details see Report No. 42.

## 7.5 REVISE ROAD MAINTENANCE BUDGET HEADS

The GoUP makes budget allocations for maintenance works under a 'non plan' budget head which also covers general administration, emergency works, and overhead expenses. The 'non plan' budget head is normally considered as non-productive, therefore least priority is accorded to the maintenance of the road network. Sustainable road maintenance requires a steady and reliable flow of funds.

There are several reasons why this often fails to materialize. Those allocating the budget may have little understanding of the economic and social importance of road maintenance. The budget fixing process has become politicized, favouring construction, which is more visible and popular over maintenance. Yet the re-construction of a failed road is four times what it would have cost had the road been maintained and not allowed to fall into disrepair.

Maintenance should be considered as an investment and not as an expense. The PWD Annual Report should include Asset Value so that the road users can see the financial state of the road network and if it is improving overall from one year to the next, or deteriorating, as it is at present.

Separate budget heads should be created for:

1. Maintenance Works: this must include routine and periodic maintenance
2. Establishment: with separate headings for salaries, supplies, vehicles, and offices and
3. Emergency Works.

The budget for 'plan works' should be set against GoUP policy and the Road Network Master Plan. Ad hoc requests at Division level should be ignored. Such requests must be made to the respective Zone so that they can be taken into account when the Annual Budget is prepared and only justified after full economic and other appraisals have been completed.

## 7.6 RENEWAL CYCLE

The current process of maintenance based on a renewal cycle should be discontinued immediately. It is anything but cost effective and elsewhere has been proved to be a waste of money and effort.

Time based resurfacing systems such as renewal cycle are arbitrary without any scientific or technical base. Instead the concept of condition based intervention criteria for road surfacing should be introduced in the State. Intervention criteria should be based the measurement of some of the service level parameters given below:

- Roughness
- Rutting
- Potholes
- Skid resistance
- Cracking

## 7.7 IMPROVE QUALITY CONTROL ON MAINTENANCE WORKS

Quality control testing on routine maintenance activities is seldom taken seriously in the PWD. The routine maintenance activities are left at the mercy of the road gangs, without giving any serious considerations as regards the quality of works executed. Supervision is poor and no standards or guidelines given to the gangers with respect to the methodology to be adopted for pothole filling of patching.

In order to improve the quality of routine maintenance activities supervisory engineers must exercise adequate quality control checking and testing on routine maintenance works. A Quality Manual exclusively for routine maintenance works should be brought out by the PWD. The manual should contain quality control norms, checking and testing frequencies, acceptance criteria and specific responsibilities of the supervisory engineer.

Further a system for periodic assessment of the effectiveness of the maintenance activities should be evolved in PWD. A Quality Management Unit will be formed in the PWD and a Quality Audit must be undertaken. However the Quality Manual, Quality Management Unit, and Quality Audit will be useless without the will to improve quality and the assurance that effective penalties will be imposed where the quality is not to the required standard.

For further details see Report Nos. 19 and 30.

## 7.8 IN-HOUSE MAINTENANCE

It is envisaged that the Non-core Road Network will be maintained using gang labourers. The permanent maintenance Ganger should be entrusted with full responsibility for carrying out routine maintenance of a specific length of road. It is not sufficient to simply entrust the job to permanent gang men: they must be supervised, supplied with materials, tools replaced, and quality kept up through frequent inspection.

The present maintenance is delivered by traditional in house labour-intensive maintenance system, involving use of road gangs over short road stretches. This in house traditional system of maintenance through permanent labour gangs is expensive and non productive.

The gang workers on the permanent rolls of PWD are mostly incapacitated because of advanced age. The date of birth shown in the records for most of the permanent work charged staff is erroneous and the recorded age is much less than actual age. Because of advanced age the efficiency of doing physical work is considerably much less resulting into much lower output.

The performance of the gang labourers must be improved through careful selection, training, supervision of their work, and adequate compensation for work done. This may incorporate setting maintenance standards for a given length of road with the labourers receiving a bonus if no section of the road falls below a stated and measurable standard.

In certain specific urgent cases, such as emergency works, engaging casual labour may become inevitable, the labourers so engaged should be selected according to criteria of fitness and competence and paid a market wage, preferably by piecework.

Some of this is covered in Report No. 3.

## 7.9 OUT-SOURCING MAINTENANCE

Revised conditions of contract have been prepared (see Report No. 21) and should be implemented by the PWD. However, as with quality management, the PWD must be willing, and enabled, to impose penalties on those Contractors who fail to comply with the contract conditions.

It is envisaged that all construction, upgrading, and maintenance on the Core Road Network will be out-sourced. Under these circumstances the PWD must be equipped and empowered to supervise the works, check physical and financial progress, and test the quality of work. Failure by the Contractor to perform according to his contract must lead to penalties being imposed on the Contractor that will be upheld in a Court of Law.

Over a period of time the PWD should introduce Performance Based Maintenance Contracts (see Report NO. 54), but only when PWD staff and the Contractors have been trained in the administration and performance requirements of such contracts. These types of contract are very different from the current forms of contract. PWD staff and the Contractor need to be made aware of the differences and the responsibilities of each party.

## 7.10 IMPROVE RANGE OF MAINTENANCE TREATMENTS

Maintenance treatments in use in the PWD are mostly labour intensive. The main activities under routine maintenance are pothole filling and patching on bituminous surfaced roads, reshaping of earthen shoulders, trimming/overlapping of road side tree branches, and clearing drains. Repairs to rain cuts on shoulders and slopes are occasionally attended to, but sealing or filling of cracks is generally not undertaken.

Documented performance of pavement maintenance interventions is important so that the PWD can determine those interventions which are most appropriate under particular circumstances.

The treatments listed below cover periodic maintenance:

### Surface Dressing

Surface dressing is a simple and inexpensive road surface treatment which is highly effective if adequate care is taken in the planning and execution of the work. A surface dressing comprises of thin film of 'binder', generally bitumen, covered with a layer of stone chippings and can fulfil any of the following functions:

- Provide a waterproof seal to the road surface, thus preventing the ingress of surface water to the lower layers of the road pavement.
- Arrest deterioration of an existing road surface that is showing signs of distress.
- Restore the skid resistance
- Provide a dust-free and durable running surface for a previously untreated mechanically stable road base.

Surface dressing is a very important maintenance technique which is capable of greatly extending the life of an existing sound road pavement if the process is undertaken at the optimum time. Under certain circumstances surface dressing also is able to retard significantly the failure of a structurally inadequate road pavement postponing for a while the need for a structural overlay or pavement reconstruction.

The use of mechanized surface dressing technique is recommended for providing a renewal coat for flexible pavements on all kinds of roads with a traffic volume up to 4000 CV/day. Contractors should be encouraged to acquire equipment that can be used for the application of mechanised surface dressing.



### Fog Seal

Fog seal is a light spray application of dilute bitumen emulsion used primarily to seal an existing bituminous surface to reduce ravelling and enrich dry and weathered surfaces. Fog seals are also used as enrichment treatment since they add fresh bitumen to an aged surface and enhance the pavement surface life. Fog seals are also used for sealing narrow cracks on bituminous pavements.

Fog seals are a method of adding bitumen to an existing pavement surface to improve sealing or water proofing, prevent further stone loss by holding down aggregate in place, or simply improve the surface appearance. Fog seal application is mostly done on old or damaged open textured surface. This includes surface dressing; heavily aged dense and open graded surfacing.

Fog seals (with sand blotter coat) may be used as a pavement maintenance treatment on roads (and shoulders) with low traffic volumes roads and low speeds.

The fog seal may be used to help retain chippings on a new surface dressing that may be poorly held for some reason.

### Slurry Seal

Slurry seal is a cold mix paving system that can remedy a broad range of problems on road pavements. The principal material used to create slurry seal are aggregate, bituminous emulsions and fillers, which are mixed together according to design mix formula. Water is also added for workability.

Slurry seal is unique in its ability to deposit a durable bituminous mixture in accordance with the demands of variable textured surface, such as filling cracks and voids, sealing the surface making it impervious to water. Existing distresses in older pavements, such as surface cracking, ravelling, loss of matrix, increased water and air permeability and lack of friction due to flushing or aggregate polishing, can be corrected through a slurry application. Waterproofing is also achieved, preventing further deterioration.

An all-weather, long lasting surface is created that offers skid resistance and improved driving characteristics. It is economical to lay and highly cost effective with a simple application. Slurry seal application is recommended on surface dressed bituminous pavements for holding the chippings very securely and providing a durable, impervious, and non skid surface.

### Milling and Recycling the Bituminous pavement

Road building materials, particularly crushed stone aggregates, are scarce in the State of UP, therefore the recycling of reclaimed bituminous pavement materials for rehabilitation of highway pavements should be considered for adoption in the State.

When recycling the existing pavement materials are mixed (in place or at a plant) with or without the application of heat and reused. The reclaimed bituminous pavement material is obtained by milling, planing or crushing the existing pavement. New aggregate or recycling agent (bitumen based) or both are added to the reclaimed bituminous pavement material so as to meet the required specification. The re-mixed material is then laid and compacted.

The use of cold/hot in-place or plant recycling can restore an old pavement to the desired profile. The process can eliminate existing wheel ruts, restore the crown and cross slope, eliminate potholes, irregularities and rough areas. It can also eliminate transverse, reflective, and longitudinal cracks.

Some of the major reasons for the increased use of cold in-place recycling are the increased scarcity of materials, particularly gravel and crushed rock, coupled with the cost of bitumen and a growing concern for depleting petroleum reserves.

The method's high production rate and potential savings, minimum traffic disruption, ability to retain original profile, reduction of environmental concerns, and cold in-place recycling is attractive. However these savings need to be balanced against the initial cost of the plant and its maintenance, including provision of spare parts. In-place recycling is economically more attractive than cold central plant recycling, particularly for secondary low-volume roads that are located at a considerable distance from a central plant. Cold in-place recycling does not involve hauling reclaimed bituminous paving materials to a central plant and then hauling the cold recycled mix back to the job site

The process can be carried out by using a single machine for milling, mixing, and laying, or by a train of specialized equipment for different steps including milling, crushing, screening of the reclaimed bituminous paving materials, and mixing.

The moisture content of the recycled mix must be carefully monitored to prevent excessive moisture which can cause stability problems, or insufficient moisture which can affect mixing and reduce workability. The mix may require aeration, as an aid to evaporation, before compaction to reduce the excess fluid content. Although cold in-place recycled mix produces a stable surface, a wearing surface consisting of hot mix asphalt or seal coat is normally required because the recycled surface is not adequately resistant to abrasion by traffic and moisture intrusion.

## 7.11 IMPROVE RANGE OF MATERIALS

### Geosynthetics.

Geosynthetic is a general term for all synthetic materials used in geotechnical engineering applications. It includes Geotextiles, Geogrids, Geonets, Geomembranes, and Geo-composites. They are mostly used for new construction, rehabilitation, and reconstruction works of roads, bridges and structures. These materials are now increasingly being used for maintenance of roads and bridges.

There are many geosynthetic products which are being used in road building and maintenance. However, prior to using geosynthetics products in maintenance work it is advisable to conduct a detailed study of the product from techno-economic considerations

Some application areas for geosynthetic materials and their functions are given in Table 4.

**Table 4 : Application Areas for Geosynthetic Materials**

Application area	Geosynthetics involved	Function for performance
Embankment on soft soils	Geotextiles, Geogrid	Reinforcement, Separation
Retaining walls	Geogrid, Geotextiles	Reinforcement
Drainage and filtration	Geotextiles	Filtration, Separation
Erosion control Rip rap	Geotextiles	Filtration, Separation
Bituminous Overlays	Geotextiles, Geocomposites	Barrier, Reinforcement, Separation

### Geotextiles

Geotextiles are flat, permeable, polymer-synthetic (PET, PVA, PP) or natural textile materials which can be non-woven, knitted or woven. They are used in contact with soil or other materials in civil engineering earthworks and building construction. Geotextiles can be used to provide separation, filtration and reinforcing functions in a structure as indicated by the following applications:

1. Sub-grade / road base improvement
2. Pavement enhancement
3. Sub-surface drainage – Sub-surface drains
4. Erosion control
5. Walls and slopes

### Woven Geotextiles

Woven geotextiles are flat fabrics consisting of two mutually perpendicular sets of threads bonded with fabric weave. They are mostly used as ground stabilization fabrics, having high tensile strength at low elongations, and reduce maintenance costs and improve the performance of paved and unpaved surfaces.

Ground stabilization fabrics minimize rutting and prevent intermixing of the aggregate with the soft soils below. These fabrics save time and money by reducing or eliminating the need for additional crust.

As stabilization geotextiles are placed between the aggregate and the sub-grade to preserve the aggregate and reinforce the surrounding soil. When used below the sub-grade geotextile fabrics prevent 'pumping' thus keeping mud from contaminating the sub-grade.

### Knitted Geotextiles

These are manufactured by looping of one or more yarns, fibres or other elements. Both geotextiles, woven and knitted, are beneficially used for a wide range of both cohesive and non-cohesive soils and they support quick formation of a natural soil filter. They facilitate dissipation of pore pressures and, because of their strength characteristics and low elongation, improve mechanical properties of soil and enable the construction of reinforcing ground structures in this way.

### Non-woven Geotextiles

These are multi-purpose fabrics that are felt-like in appearance. There are numerous practical applications for non-woven geotextiles since they provide an economical alternative to graded aggregate and sand filters. They overcome many of the problems associated with using aggregates, which are costly, may be difficult to obtain, and can have high transportation costs.

Non-woven geotextiles can be used as asphalt overlay fabric which increases pavement life by providing a solution for reflective cracking. In addition, non-woven geotextiles can be used in landscaping applications to retard weed growth. They are also useful for separation, performing well under paved walkways or railroad tracks.

### Biaxial Geogrids

Biaxial geogrids are designed to have roughly the same tensile strength in both directions and to distribute loads over a wide area thus increasing the bearing capacity of the soil. Base reinforcing geogrids interlock with the aggregate to confine the base and reinforce the sub-grade. In paved or unpaved applications, they reduce rutting and help maintain the desired aggregate depth.

Some uses of Biaxial Geogrids are:

- Pavement Improvement Systems: providing sub-grade improvement and base reinforcement solutions that extend service life, reduce maintenance, and lower overall costs.
- Foundation Improvement Systems: providing stable and reliable building foundations for sites with poor soil conditions.
- Improve Site Access: Biaxial Geogrids help improve access to the site in any weather or soil conditions. They provide a firm, free draining access road which is quick and easy to construct. Simply roll out the biaxial geogrid and cover with a layer of aggregate fill.
- Reduce Cut and Fill: removing unsuitable material is expensive. It is possible to work on top of a layer of weak soil simply by placing a layer of Biaxial Geogrid over the unsuitable material and covering it with aggregate. The result – less undercutting, backfilling, and less transport and disposal costs.
- Reduce Aggregate Fill Thickness: Biaxial Geogrids can reduce the thickness of the fill layer by as much as 50% while achieving the same bearing capacity and serviceability as thicker, un-reinforced fill.

### Uniaxial Geogrids

Uniaxial Geogrids typically have their tensile strength in the machine (roll) direction. They are mainly used to reinforce the soil mass in a steepened slope or segmental retaining wall. They can also function as a wrapping to confine the aggregate in the wire forms of welded wire faced steepened slopes.

### Geo-composites:

Geo-composites are polymer products and are used both for soil (separation and reinforcing function) and for asphalt pavements (reinforcing function, especially for repairs).

Bituminous materials have low tensile strengths which result in the formation of cracks that can lead to reduction of usability and service life of bituminous toppings. Geo-composites are most frequently used as reinforcing geo-synthetic materials for bituminous layers. By careful design they can increase the tensile strength of the bituminous layers by carrying a considerable part of the horizontal tensile stresses and ensure their uniform distribution over larger areas.

Geo-composites can also prevent the formation and spreading of reflex cracks by absorption of shear forces. A properly designed geo-composite reduces permanent deformations and rutting. Geo-composites can be used for reinforcement of both new bituminous roads and roads already damaged by cracks. Road service life is extended considerably reducing the creation and spreading of reflex cracks.

## **7.12 IMPROVE PAVEMENT PREPARATORY WORKS**

Pavement preparatory works are required to be carried out on the existing bituminous pavement prior to application of overlays or renewal layers. These works include pothole filling, crack sealing, and repairs to localized distorted surface and profile corrective courses.

Pavement preparatory works should invariably be included in maintenance works. Standards for pavement preparatory works should be developed and steps taken to ensure that these works are performed in accordance with those standards.

## **7.13 ROAD SAFETY**

Road safety is a most neglected aspect of road maintenance work. Road safety measures as recommended by IRC should be strictly enforced while carrying out road maintenance works.

See Report No. 46 for further details.

## **7.14 ENVIRONMENTAL CONSIDERATIONS**

Environment is seldom taken into account in the design and implementation of road maintenance tasks in UP PWD. While impact might be gradual because of the limited size of maintenance works, it is noticeable throughout the road network. The frequency of road maintenance operation can facilitate the implementation of standard good practices.

Environmental considerations should be included in road maintenance programmes and should be looked at from a methodology, technical, economic, and institutional or contractual issues.

See Report No. 20 for further details.

## 7.15 ESTABLISH AND IMPLEMENT TRAINING COURSES

Training courses on road maintenance should be run for PWD staff, Gangers, and Contractors. This is one of the most fundamental and critical aspects for successful implementation of programmes related to road maintenance works of all kinds. PWD staff engaged in managing the maintenance operations in PWD should be trained in all aspects of road maintenance including condition and other surveys, and in the use and application of road maintenance management systems.

The training programme should focus on new and better methods of road maintenance and asset preservation. Training should be a continuous process to ensure that all concerned are kept up to date with developments in the field of road maintenance.

Training courses should include the following:

Senior Engineers: The challenge for Senior PWD officials is to establish cost-effective programmes. Due to the sheer size of the road network and the number of features that must be cared for; plus the varying age and physical conditions and limited budgets, PWD officials are faced with problems that can no longer be solved with intuitive approaches. A systematic approach, based on sound management and engineering principles, is needed to determine the cost-effective programmes to maximize the use of available funds.

To help alleviate some of these problems it is essential to develop management systems for use in PWD. These include Pavement Management Systems (PMS), Bridge Management Systems (BMS) and Road Maintenance Management Systems (RMMS). Senior officials should be trained for using these management systems in the field of planning, design, construction and maintenance of roads.

Field Engineers and Technicians: Field Maintenance Engineers, Technicians and Gangers must ensure that work procedures are performed in accordance with correct and efficient fundamentals so that maintenance and repair works last longer and available funds go further. The training should cover the appropriate materials, plant, equipment, and tools used in each maintenance activity.

In particular the training should focus on the topics listed below:

1. Common maintenance problems and causes,
2. Traffic control during maintenance operations
3. Repair to pavements (bituminous, rigid and gravel) of all kinds, base and sub-base
4. Cleaning of lined and unlined drains, ditches culverts, and catch basins
5. Repairs to earthen, gravel and paved shoulders

6. Cleaning and clearing of bridges
7. Concrete bridge deck repairs including expansion joints, bearings, and wearing coats
8. Single and multiple surface treatments, slurry seal, and fog seal.
9. Quality control tests

For more complete details see Report No. 36.

## 8. ESTABLISH ROAD MAINTENANCE STANDARDS

### 8.1 GENERAL

Road maintenance standards define the minimum level of quality or serviceability at which the road is to be maintained, and promote uniform maintenance levels in all parts of the State. They should be developed to give specific directions to maintenance crews including what should be done, when the work should be done, how it should be done, and what resources are required.

Three types of maintenance standards are proposed: namely Quality Standards, Quantity Standards, and Performance Standards. The defined maintenance standards are the accepted minimum threshold levels established for road maintenance, and should address all road characteristics such as smoothness, longevity and congestion.

Maintenance standards can be categorised as follows:

1. Road user Service and Comfort measures, which can be expressed in terms of:
  - Roughness
  - Road and lane width
  - Rutting
  - Skid resistance
  - Vegetation control
  - Visibility of road signs and markings
  - Response time to rectify defects that compromise the safety of road users
  - Attendance at road accidents
  - Drainage off the pavement
2. Road durability measures expressed in terms of:
  - Longitudinal profile
  - Pavement strength
  - The extent of repair permissible before a more extensive periodic maintenance treatment is required
  - Degree of sedimentation in drainage facilities
3. Management performance measures which define the information that senior management requires to monitor and govern the asset
  - Progress reports to the Senior Management authorities of PWD
  - Inventory updates and data sharing requirements
  - Maintenance History



## 8.2 STANDARDS FOR ROUTINE MAINTENANCE ACTIVITIES

Routine maintenance is day-to-day repair of minor defects that need to be carried out to arrest further deterioration, and to ensure the safety of road users. Filling potholes and clearing drains are good examples of routine maintenance activities. It also includes those activities which need to be undertaken on annual basis, such as painting road signs.

Routine maintenance works are funded from the recurrent budget which is part of the non-plan budget. Activities can be grouped into cyclic and reactive works types. Cyclic works are those undertaken where the maintenance standards indicates the frequency at which the particular activities should be undertaken. Cyclic maintenance works include verge cutting, culvert cleaning, both of which are dependent on environmental effects rather than traffic levels. Reactive works are those where intervention levels, defined in the maintenance standards, are used to determine when the maintenance is needed.

Routine maintenance is to be undertaken according to an agreed set of criteria setting out when and what type of work is required. Prior to enforcement of standards for maintenance activities the PWD needs to establish a policy regarding development, enforcement, and monitoring of maintenance standards for the Core Road Network.

Generally the following terms, which are explained in the following Sections, are used in the context of enforcing and monitoring the standards for road maintenance:

- Intervention Level
- Response time
- Performance criteria
- Performance standards

### 8.2.1 Intervention level

In order to determine when and what type of routine road maintenance is required to be carried out it is of the utmost importance to establish an agreed set of criteria.

The basic principle of establishing an agreed set of criteria is to classify the defects or distress in order of severity and set in a level beyond which further deterioration is not permitted from consideration of cost and safety of the road user. The level of defect or distress is defined in terms of 'Intervention level'. The 'intervention level' defines the severity of the defect or distress that initiates (triggers) rectification work to commence.

### 8.2.2 Response Time

Once a defect has reached 'Intervention Level' the severity of the type of defect sets the period of time in which to remedy the defect or distress. If the defect or distress has serious safety implications for the road user the repair should be 'immediate'.

The Response time is the designated time period in which the rectification of the distress or defect must be completed, once the defect/distress has been noted to be at 'Intervention level'.

The period to repaint a guard stone may not be as critical as patching a pothole and the Response time would reflect this priority.

### 8.2.3 Performance criteria

The performance criteria explain as to why rectification of particular distress or defects needs to be done together with the end result of the rectification process. For example, when considering the repair of pothole the performance criteria may be described as “The road surface and pavement should be restored to a smooth, free draining, and watertight well compacted, stable and safe condition.”

The relevant performance criteria are ride quality, permeability resistance to water, and integrity of surface.

### 8.2.4 Performance Standards

Performance standards prescribe what will be the minimum standard of repair for a particular piece of work For example, the performance standards for repairs to a pothole may be set out as follows:

*“Pothole repairs will be carried out that will restore the paved surface to a smooth, free draining, impermeable, well compacted, stable and safe condition using materials that are generally compatible with the existing pavement ,or better, and must meet the MORTH specifications for materials.*

*Ride Quality: The resultant patch should have a test result under a 1.2 m straight edge of – 0/+5 mm in any direction.”*

The Intervention level, performance standard, and response time will vary according to the category of the road.

## 8.3 IDENTIFICATION OR CODE NUMBER OF ROUTINE MAINTENANCE WORKS

An identification, or code number, should to be assigned to each defect which is likely to be rectified or attended to under routine road maintenance. Intervention levels, response times, and performance standards for the various elements or defects can be identified using this identification or code number as shown in Table 5.

**Table 5 : Identification or code number for various elements or defects**

Code No	Defect Name	Remarks
<b>SURFACE MAINTENANCE</b>		
<b>RM 100 Bituminous Pavement maintenance</b>		
RM 101	Roughness	
RM 102	Pothole filling & Patch repair	
RM 103	Edge break	
RM 104	Surface depression	
RM 105	Surface rutting	
RM 106	Surface corrugations	
RM 107	Cracking	
RM 108	Crocodile Cracking	
RM 109	Ravel/strip/fretting	
RM 110	Delamination	
RM 111	Bleeding	
RM 112	Surface Failures	
<b>RM 200 Concrete Pavement</b>		
RM 201	Roughness	
RM 202	Joint sealant	
RM 203	Spalling/broken concrete	
RM 204	Faulting/Stepping concrete	
RM 205	Concrete crack repair	
<b>RM 300, WBW and Earthen Roads</b>		
<b>RM301</b>	<b>Roughness</b>	
RM 302	Potholes and edge break in WBM	
RM 303	Low shoulder WBM	
RM 304	Potholes, gullies and corrugation in gravel roads	
RM 305	Camber	
RM 306	Formation height or drainage	
RM 307	Failed pavement	

Code No	Defect Name	Remarks
<b>RM 400 Shoulders</b>		
RM 401	Edge drop	
RM 402	Deformed / potholed	
RM 403	High shoulder	
RM 404	Scoured	
RM 405	Pavement surface cleaning	
RM 406	Rock and Debris Removal	
RM 407	Roadway structure maintenance	
RM 408	Curb barrier and island maintenance	
RM 409	Railway crossing maintenance	
RM 410	Roadway Structure Maintenance	
<b>RM 500 Drainage Maintenance</b>		
RM 501	Ditches, drains and water courses	
RM 502	Culverts and Drainage appliances	
RM 503	Stream Bed and Bank Maintenance	
<b>RM 600 Roadside Maintenance</b>		
RM 601	Roadside Mowing	
RM 602	Roadside Brushing	
RM 602	Roadside Litter collection and graffiti removal	
RM 603	Roadside Rest area Maintenance	
RM 604	Roadside Landscaping maintenance	
RM 605	Roadside Fence maintenance	
<b>RM 700 Traffic Maintenance</b>		
RM 701	Road Sign, distance stones, guard stones and delineation Maintenance	
RM 702	Roadway surface reflector maintenance	
RM 703	Pavement marking maintenance	
RM 704	Traffic Patrol	
RM 705	Traffic Control	

Code No	Defect Name	Remarks
<b>RM 800 Structure Maintenance</b>		
RM 801	Bridge Deck Maintenance	
RM 802	Bridge Structure Cleaning	
RM 803	Bridge drain and Flume Maintenance	
RM 804	Bridge Joint Maintenance	
RM 805	Bridge Bearing Maintenance	
RM 806	Concrete Structure maintenance	
RM 807	Steel Structure Maintenance	
RM 808	Steel works painting	
RM 809	Bridge Piling Maintenance	
RM 810	Retaining Structure maintenance	
RM 811	Bridge Railing Maintenance	
RM 812	Tunnel maintenance	
<b>RM 900 Emergency Maintenance</b>		
RM 901	Flood Control and washout Response	
RM 902	Mud, Earth and rock slide response	
RM 903	Roadway accidents and vandalism response	
RM 904	Structural damage response	
RM 905	Storm damage response	
<b>RM 1000 Inspection maintenance</b>		
RM 1001	Roadway Inspection	
RM 1002	Roadway Patrol	
RM 1003	Bridge Inspection	

#### 8.4 GUIDELINES FOR SETTING MAINTENANCE STANDARDS

Maintenance services should be set for each maintenance standard in accordance with the guidelines given below:

Maintenance Service:

This should include a brief description of objective or intent of each maintenance standard or activity and the level of service required. Requirements of Routine Maintenance services for each specific activity should also be included in this section.

Specification:

This section deals with materials, performance standards, methods to be used, and any miscellaneous requirements or specifications of each maintenance standard.

Maintenance Criteria, Intervention level and Response Time:

The conditions which necessitate routine maintenance services including maintenance criteria, intervention level, response times, and frequencies are set out in this section for each maintenance standard.

Criteria that might be considered in setting out maintenance standards include:

- Availability of a standard test procedure for the matrix
- Feasibility of applying the performance standards within the context of road maintenance.

To be truly effective, standards should be set at a level of performance well above average, but within the bounds of what has been achieved with current best practices and technologies. That is, they should require that agencies and Contractors strive for excellence without setting a goal that cannot be achieved.

## 8.5 MAINTENANCE STANDARDS

A typical example of maintenance standards for filling potholes and patch repair work on bituminous pavement is illustrated as follows:

<b>Code Number</b>	<b>Defect Name</b>
RM 102	Filling Pothole and patch repair work on bituminous pavement

### A. Maintenance Service

Filling Potholes and patch repairing will be performed as required on bituminous pavements so as to:

- a. Maintain the pavement surface in a smooth, stable, and safe condition for the road users;
- b. Seal pavement from moisture penetration;
- c. Prepare and strengthen a paved roadway surface for an overlay or resurfacing
- d. Extend pavement life

This maintenance service includes filling potholes and patch repairs on the pavement surface that has been damaged, or has deteriorated, to a state where the deficiencies constitute, or have the potential to create, unsafe conditions for the road users. The purpose of pothole filling and patch repair is to assist with the preservation of the pavement asset by restoring the integrity of the pavement surface and to remove an existing or potential safety hazard.

Pothole filling and patch repair may be performed using spray patch method or mix material method under routine maintenance activities in accordance with this maintenance standard.

## B. Specifications

Materials: All materials used for pothole filling or patching shall be in accordance with the clause 3004.2 of MOSRTH Specifications for Road and Bridge works (fourth revision) including:

- a. Hot mix crushed aggregate and bitumen materials
- b. Cold mix crushed aggregate and bituminous emulsion materials
- c. Cover aggregate and bitumen for spray patch
- d. Tack coat materials

## C. Maintenance Criteria

The road surface and pavement should be restored to a smooth, free draining, water tight well compacted, stable, and safe condition. The relevant performance criteria are ride quality, permeability, resistance to water, and integrity of the surface.

## D. Intervention Level and response Time

A typical example of response times is given in Table 6.

**Table 6 : Typical Intervention Levels and Response Times**

Category of Road	Intervention Level	Response Time	Performance Standard
State Highways	Repair all potholes more than 150 mm (least size) across and 20 mm deep. Potholes must not allowed to become more than 30 mm deep and 200 mm in diameter	Those that are safety hazard - Immediate Otherwise within 48 hrs	All repairs shall comprise materials that are generally compatible with the existing pavement or better and meet the MORTH IVth Revision specification.
Major District Roads and Other District Roads	Repair all potholes more than 200 mm (least size) across and 25 mm deep Potholes must not allowed to become more than 30 mm deep and 250 mm in diameter	Those that are safety hazard - Immediate Otherwise within 3 days	<u>Ride Quality:</u> The resultant patch should have a test result under a 1.2 m straight edge of - 0/+5 mm in any direction.
Village Roads	Repair all potholes more than 250 mm (least size) across and 40 mm deep. Potholes must not allowed to become more than 50 mm deep and 300 mm in diameter	Those that are safety hazard - Immediate Otherwise within 7 days	<u>Permeability:</u> The surfacing should provide a uniform water resistance layer to protect the pavement from surface infiltration of moisture

## 9. FOCUS GROUP MEETING

Focus Group I meetings were held on 05.12.07 and 19.02.08 on Report No.44: Report on Implementation of Upgraded maintenance Practices and standards for core network.

1. Chairman of Focus Group (FG) advised that 'in house' maintenance should be performed through mobile units comprising of permanent gang labour. The mobile unit should be provided with a vehicle for transportation of labour, material, tools and plants and equipment. Beat and jurisdiction of each mobile unit should be pre-decided by the PWD. The mobile unit should be equipped with such equipment and tools which are often used for carrying out maintenance works. By introducing mobile units, the permanent gangs will be fully utilized resulting into saving in both time and money.
2. The Chairman of Focus Group opined that as far as possible the maintenance operations should be mechanized, which will enhance the efficiency of work force and quality of work.
3. Focus Group desired that the upgraded maintenance practices should also be equally applicable for non core road network also.
4. TA consultant was in agreement with the opinion of Focus Group and stated that the Focus Group's views would be taken care by the Cell responsible implementing these recommendations.
5. The Focus Group approved the Report on Implementation of upgraded maintenance practices and standards for core network therefore the final report may be issued.



## **10. PRESENTATION TO PROJECT STEERING COMMITTEE**

**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

**PWD Focus Group - I**

D.V.S. Sarawat	MD UPSBC
Surendra Kumar	Jt. M.D., U.P. State Bridge Corporation, Lucknow
Arun Kumar	EE, CD-1, Aligarh
Rajan Mittal	EE, PD, Saharanpur
Anurag Asthana	AE, UPRRDA, Lucknow
Navin Kumar	AE, TY. DCU (NH), Lucknow
Anay Kumar Srivastava	AE, IDS Cell, Lucknow
Sandeep Saxena	AE, IDS Cell, Lucknow

**LEA International Ltd. & LEA Associates South Asia Pvt. Ltd.**

Shri S.K. Pancholy Contract and Procurement Specialist



**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

**UP PWD Road Maintenance - Key Recommendation of IDS Consultant (TCE):**

*“Maintenance process should be strengthened by adopting a systematic approach to decision making. This can be done through application of techno-economic and financial criteria, setting consistent standards, adopting cost effective technologies, effective allocation of resources and periodic review of policies, standards and measuring the effectiveness of the programme.”*

**Action Mile stone:**

*“Implement Upgraded maintenance Practices and standards for core network”*



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Methodology & Purpose:

1. Overview of road maintenance issues
2. Review road management /maintenance practices followed in UP PWD, GOI and other states of India.
3. Identify areas for improvement.
4. Suggest upgraded practices and standards for maintenance of core network roads

Purpose: Suggest guidelines in the process of implementing upgraded maintenance practices and standards for UP core road network.



**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

**Categories of Maintenance**

- Routine maintenance
- Periodic Maintenance
- Emergency Maintenance
- Rehabilitation
- Reconstruction & Upgrading



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Objectives of Road Maintenance

1. Preserve the road assets and user safety
2. Preserve the aesthetics and compatibility of the highway system with the environment.
3. Provide Comfort , convenience and safety to the road users
4. Maintain a highway system that provides the safest practicable environment for road users and workers.
5. Establish and maintain procedures for maintenance and emergency operations that provide for safe highway and transit operating conditions during these activities.
6. Reduce the deaths, injuries and damage due to accidents on highways.



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### REQUIREMENTS OF ROAD MAINTENANCE:

- Maintenance Programming & Planning comprises of
  - Identify needs- Inspection and accident records
  - Establish priorities
  - Establish procedures
  - Technology



**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

**Review of Maintenance Practices**

Gujarat

Maharashtra

UP PWD Maintenance Manual

Maintenance practices in UP PWD





## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Deficiencies

- Maintenance and rehabilitation measures for pavements are based on subjective judgement and past experience of the Highway Engineers.
- Non –availability of analytical tools for use by the Highway Agencies to assist in selecting the optimum strategy based upon “life cycle cost”.
- The PWD lacks an effective road management and maintenance system
- Causes of pavement deterioration are not investigated due to lack of data on design, construction, and maintenance aspects of the pavement.
- Budget allocation for road maintenance is based on a percentage of the norms requirements (the percentage is getting smaller) and use of labour intensive maintenance methods that do not meet the maintenance requirements and frequently result in a waste of resources.



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Deficiency continued

- The allocation of funds fails to meet 30 to 40 per cent of the annual maintenance requirement for the road network.
- Apart from funds, weak planning, poor scheduling and monitoring of maintenance operations, inherent deficiencies in the crust thickness, and lack of attention to drainage have contributed towards the accelerated deterioration of the road network.
- Lack of proper coordination between different components of road maintenance work and different organizations.
- Lack of multi-year or strategic planning leading to ineffective resource allocation and investment inefficiency;
- The specifications laid down for materials and machinery are seldom followed
- Bituminous materials/mixes are not properly designed and produced for maintenance.
- The surface is not checked and corrected for cross slope and undulations so that no levelling course is provided to make up for same.



**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

**RECOMMENDATION OF IDS CONSULTANTS**

- ✓ Strengthen Maintenance Process
- ✓ Maintenance Budgeting
- ✓ Maintenance Operations
- ✓ Introduce new technology maintenance methods
- ✓ Quality Control



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Recommendations for Upgrading Maintenance Practices.:

- Revise Existing Road maintenance manual
- Organizational Restructuring
- RMMS
- Revise Road Maintenance Budget heads
- Condition base renewal cycle
- Improve Quality Control on Maintenance works
- In house maintenance
- Outsourcing maintenance
- Improve range of maintenance treatments such as Surface Dressing, Fog seals , slurry seals, Milling & recycling
- Improve Range of materials – Geosynthetics, Geotextile,
- Improve pavement preparatory works
- Road Safety
- Environmental considerations
- Impart training



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Road Maintenance Standards:

#### Category of Maintenance Standards

1. Road user service and comfort measures – Roughness, Rutting, Skid resistance, lane width, visibility of road signs, drainage on pavement,
2. Road durability measures such as pavement strength, longitudinal profile etc
3. Management performance measures: Progress reports, inventory updates, Maintenance history



## Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network

### Standards for Routine Maintenance

Terms used in this context are:

1. Intervention level- It defines the severity of the defect that initiates rectification work to commence.
2. Response time- It is designated time period in which the rectification of the defect must be completed
3. Performance criteria: It explains why rectification of particular distress needs to be done and with end results of the rectification process.
4. Performance standards: It prescribes what will be minimum standard of repair for a particular piece of work.



**Report No. 44 - Review Report on Implementation of Upgraded Maintenance Practices and Standards for Core Network**

Identification or code Number of Routine Maintenance works



### Typical Example

Category of Road	Intervention Level	Response time	Performance standards
SH	Potholes >150mm (least size) and 20mm deep Not allowed to become >30mm deep and 200mm in dia	Immediate if safety hazard Otherwise within 48 hrs	Materials compatible with the existing pavement or better and meet specifications  Ride quality +/- 0.5mm on 1.2 m st edge  Permeability: Water resistant
MDR & ODR	>200mm least size and 25 mm deep Not allowed >30 mm deep and 250mm in dia	Immediate if safety hazard Otherwise within 3 days	
Village Roads	>250mm and 40 mm deep Not allowed 50mm deep and 300 mm dia	Immediate if safety hazard Otherwise within 7 days	