

# PERFORMANCE BASED RURAL ROADS MAINTENANCE



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## 1. INTRODUCTION

Road maintenance is a routine work performed to upkeep pavement, shoulders and other facilities provided for road users, as nearly as possible in its constructed conditions under normal conditions of traffic and forces of nature. The maintenance is essential to obtain better service from the pavement structure during its design life. A highway facility deteriorates in its level of serviceability due to traffic and environmental factors. Different distresses resulting due to the above factors are raveling, rutting, corrugations, cracking, loss of material, loss of skid resistance and structural deformation. The extent of deterioration and its rate are governed by the design standards and quality of the material used in construction. Unsealed roads get deteriorated as faster as compared to the sealed roads and hence needs greater attention. Well maintained road leads to reduced road user costs.

Earlier, the assessment of maintenance needs was done by intuition and past experiences of the highway engineers. However, maintenance needs are to be assessed on a more scientific and rational approach, which includes evaluation of pavement characteristics quantitatively. This is more pertinent in the present era of Infrastructure Development, since the roads constructed which are the assets of the nation, should be preserved for effective utilization and serviceability.

## 2. ASPECTS OF MAINTENANCE

Maintenance comprises only the work necessary to preserve the road asset in an acceptable operating standard. It does not add or extend the asset. The categories of road maintenance are:

- **Routine Maintenance-** is the repair of minor defects in existing facilities required quickly to arrest further deterioration and to ensure the safety of road users;
- **Periodic Maintenance-** 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;
- **Emergency Maintenance-** is the activities requiring rapid response to restore the asset to keep it open and make safe for the user. Emergency maintenance generally results from crashes, floods and landslides
- **Rehabilitation-** is the activity that restores the structural aspects of the existing facility to extend the life and safety of the road user;
- **Reconstruction and Up gradation-** is the activity that restores and generally improves the structural aspects of the existing facility.

The works covered under routine maintenance include Pothole and edge break repairs, surface depression and rut repair, crack repair, spalling and broken concrete repair, joint sealant repair, reshaping of shoulder, repair of deformed, low and scoured shoulder, cleaning of side drains, cleaning of blocked culverts, lined drains and pits, vegetation and scrub control, etc.

The works covered under Periodic Maintenance include black top resurfacing, gravel re-sheeting, WBM profile correction and resurfacing, Shoulder resurfacing, replacement of cross drainage, etc.

### 3. AP ECONOMIC RESTRUCTURING PROJECT (APERP)

The Government of India has obtained assistance from the World Bank for the restructuring of the public sector economy in the state of Andhra Pradesh through a multi-sector investment program, the "Andhra Pradesh Economic Restructuring Project (APERP)". This program objective is to improve the quality of life by alleviating poverty, unemployment and improving literacy. A basic road network is essential for this purpose. It was agreed that the Rural Road Component would be implemented in three pilot districts, viz. Adilabad, Karimnagar and Warangal. The CRRI has assisted Panchayat Raj Engineering Department (PRED) in the project preparation including the preparation of a road master plan, review of road design standards, development of a policy framework, identification of the project scope and village level assessment of rural transport issues. Subsequently a core network in each of the three districts was identified and the upgrading and rural road maintenance programs were chosen.

The Rural Roads Component of the APERP envisages improving the quality of life of the rural population through provision of:

- All weather access to the rural population
- Adequate maintenance of rural roads
- Sustainable policies for the construction and maintenance of rural roads

The project involves the following activities.

- Upgradation of 2848km of road length and construction of 155 bridges / CD works. Core network of rural roads in all these three pilot districts was identified with the technical assistance of CRRI, New Delhi.
- Maintenance of rural roads in the project districts
- Goods and equipment required for the project implementation
- Capacity building through engaging consultancy services for design, construction, contract supervision and Project Management Technical Assistance, etc.

The overall objective of the maintenance component is to establish financial, technical and institutional capacities in PRED for the maintenance of core network. This includes

- Establishing sustainable policies for rural road maintenance - rural road maintenance to be systematically planned, funded, contracted-out and monitored.
- Establishing a computerized maintenance management system for rural roads
- Ensure adequate funds on regular basis for the maintenance of core network
- Reduce the backlog of rural road maintenance
- Facilitate introduction of new maintenance technologies
- Introducing contract system of rural road maintenance

## 4. RURAL ROAD MAINTENANCE MANAGEMENT SYSTEM

SMEC, Australia as Project Management Technical Assistance (PMTA) has assisted PRED in the planning, procurement, supervision and execution of the upgrading and maintenance components of the project. Road Maintenance Management System was implemented for development and control of the annual maintenance program for the rural roads. A fully operational RMMS including Road Information Database (RID); Standard Schedule of Rates for Maintenance (SSRM); Road Section Rating and Prioritisation Model (RSRPM), simple procedure for development of annual maintenance budgets, road contract packaging tools and the reporting and assessing of contract expenditure and maintenance performance was developed. The major three stages are discussed in the following sections.

### 4.1 Road Data Collection

The road data is required for road rating purposes for development of the annual periodic maintenance and upgrading program and for preparing the BOQ for use in the routine maintenance contracts and covers:

- Appropriate road and section numbering
- Road inventory data collection requirements for road construction history records and mapping for use as the base layer in the GIS, and
- Road condition data collection for use in the development of the annual maintenance program

The data collection manual, has been prepared for collecting data in a consistent and uniform manner. The data collection manual also includes a road defect catalogue with the principal aim to:

- Provide a uniform terminology for the description of visible defects in pavement
- Provide a comprehensive catalogue of the major defects types for bituminous, concrete and unpaved roads
- Provide a method of quantifying each defect type
- Provide extent and criteria for rating purposes of each defect, and
- Promote the usage of defect recognition as an aid to the diagnosis of the cause of each defect

Each defect is covered in a separate road condition survey sheet to include:

- A detailed description of the defect
- A description of inspection and / or proposed measurement method
- Quantitative criteria to record the extent and / or severity of the defect
- Photos or illustrations of each type of defect
- Probable cause of the defect, preliminary symptoms and consequences if no corrective maintenance actions are carried out, and
- Any general remarks that may assist the collector in understanding the defect

### 4.2 Road Rating and Prioritisation

The road rating and prioritization mode has been prepared using simple data sheets taking into account current road condition, remaining life, road link importance (population related to traffic) and most cost effective treatment once roads are brought up to an all weather standard. The model includes the development of

- Road Condition Index (RCI)
- Road Priority Index (RPI), and
- Remaining Life Rating (RLR)

Final prioritization list will be the resultant higher value of RCI, LPI and RLR. The higher the score, the poorer is the condition of the road. From the actual road condition, the road maintenance priority is developed and

maintenance budget prepared to meet the needs of the core road network. Road condition rating calculation charts for paved and unpaved roads are presented in Table 1 and Table 2, respectively.

**Table 1: Road Condition Rating Calculation Chart for Paved Roads**

Defect type		Percentage of Damage				
Name	Criteria	<1%	1-5%	5-10%	10-20%	>20%
Potholes	>100mm	<1%	1-5%	5-10%	10-20%	>20%
Edge breaks	>200mm	<1%	1-5%	5-10%	10-20%	>30%
Surface cracks	All	<1%	1-5%	5-15%	>15%	
	>3mm	<1%	1-5%	5-15%	>15%	
Surface failures	<5m <sup>2</sup>	<1%	1-5%	5-10%	10-20%	>20%
Surface texture	<2m <sup>2</sup>	<1%	1-5%	5-10%	10-20%	>20%
Shoulder edge drop / deformation	>50mm	<1%	1-5%	5-10%	10-30%	>30%
Shoulder damage	High /Flat	<1%	1-10%	10-30%	30-50%	>50%
Joint sealant	All	<1%	1-10%	10-25%	25-50%	>50%
Concrete spalling	>100mm	<10%	10-20%	20-30%	>30%	
Remaining life	% of design	>80%	>60-80%	>40-60%	>20-40%	<20%
Rating		0	1	2	3	4
Rating score		<=10	>11<17	>17<25	>25<35	>=35
Maintenance works required		Minor Maintenance	Routine	Periodic Maintenance	Holding / Rehabilitation	Upgradation

**Table 2: Road Condition Rating Calculation Chart for Unpaved Roads**

Defect type		Percentage of Damage				
Name	Criteria	2-4	5-10	11-14	15-20	>20
Roughness	All	2-4	5-10	11-14	15-20	>20
Edge breaks (WBM)	All	<1%	1-15%	15-30%	>30%	
	>200mm					
Surface failures	<5m <sup>2</sup>	<1%	1-5%	5-10%	10-20%	>20%
Edge drop (WBM)	>50mm	<1%	1-5%	5-10%	10-30%	>30%
Camber	Low / Flat	<5%	5-10%	10-20%	20-50%	>50%
Thickness	remaining life	>100%	>75%	>50%	<50%	
Drainage / formation	Height above drain	>10	>0.75	>0.5	>0.25	<0.25
Remaining life	% of design	>80%	>60<80%	>40<60%	>20<40%	<20%
Rating		0	1	2	3	4
Rating score		<=10	>11<17	>17<25	>25<35	>=35
Maintenance works required		Minor Maintenance	Routine	Periodic Maintenance	Holding / Rehabilitation	Upgradation

#### 4.3 Standard Schedule of Rate Analysis

A revised set of Standard Schedule of Rates Analysis formats explicitly for road maintenance was prepared. Unit rates were developed using the existing formats adopted by MORTH Standard Schedule of Rate Analysis. The standard unit rates have been developed to suit all complete repair items by adding individual repair item components together to make one item unit rate. The Standard Schedule of Rate Analysis for roads maintenance has been computerized and included within the Road Maintenance Information System. The rates are linked to the Bill of Quantities (Schedule of Pricing) for preparation of the estimates and annual road maintenance budget. The rates can be easily updated by entering the revisions to Labour, Machinery, Materials and average cartage leads for each base item of materials to suit each individual Division as and when required.

#### 5. ANNUAL MAINTENANCE PROGRAMS

The major aim of the RMMS is to assist the PRED in the preparation of an Annual Maintenance Program by the 31st December each year and recommend roads to be included in the three pilot districts for the next financial year and report on the overall road condition state. The Road Section Rating and Prioritisation Model was used in the preparation of the annual periodic maintenance program.

Different defect items covered are as follows:

- Bituminous Pavement: Potholes, Surface cracking, edge breaks, corrugations, surface depressions / rutting, and bleeding

- Concrete Pavement: Joint sealant damage, cracked concrete, concrete spalling, failed concrete and stepping or faulting
- Shoulders: Low / deformed shoulder, scour and shoulder high
- Drainage: Blocked surface drains, damaged drains and culverts, blocked culverts / pits and stream scour
- Roadside: Debris / vegetation, distance markers, road signs, guard stones
- Unpaved Roads: Roughness, gravel thickness, camber / drainage, embankment height, pothole & edge repair WBM and edge drop WBM
- Bridges and Major Structures: Deck joint silted / blocked, non-structural damage, debris on or around structure, and erosion / scour

The following priority was suggested while undertaking maintenance works.

- Vegetation / scrub clearing
- Drain cleaning
- Pothole patching & edge repair
- Shoulder repair & reshaping
- Camber and profile correction of WBM
- Gravel resheeting of WBM, gravel and earthen roads, and
- Bituminous surfacing

Annual maintenance contract documents were prepared for different financial years. The annual maintenance plan for the year 2005-06 is presented in Table 3.

##### 5.1 Performance Based Contracting

The contracting is proposed to be Performance Based Contracting. It is distinguished from conventional contracting as indicated below in Table 4.

**Table 3: Annual Maintenance Plan for the Year 2005-06**

Item	Adilabad District	Karimnagar District	Warangal District	Total
<b>Routine Maintenance (RM)</b>				
RM Length, km	2,577	2,159	2,158	6,895
RM cost, (Rs.)	42,456,442	22,735,792	48,672,780	113,865,014
RM cost/km, (Rs.)	16,473	10,531	22,550	16,515
<b>Periodic Maintenance (PM)</b>				
PM Length, km	597	526	471	1,594
PM cost, (Rs.)	134,313,343	80,580,549	108,413,435	323,307,327
PM cost/km (Rs.)	225,082	153,215	230,041	202,836
<b>Provisional Items, (Rs.)</b>	4,245,644	2,273,581	4,867,278	11,386,503
<b>Total Maintenance Amount, (Rs.)</b>	181,015,429	105,589,922	161,953,493	448,558,844
<b>Average cost/km, (Rs.)</b>	<b>70,233</b>	<b>48,908</b>	<b>75,033</b>	<b>65,058</b>

**Table 4: Conventional vs Performance Based Contracting**

	Conventional Contracting	Performance Based Contracting
1	Requires intensive supervision by the department to ensure quality of work	Constant / continuous supervision not required as the contractor is bound by the contract to up-keep the road standard at intervention level agreed to in the contract
2	Requires measuring vast quantities of activities	Contractor paid monthly based on the agreed standard
3	Difficult to keep track of / measure the quantities of materials, equipment and labour, tons of pot hole patch material used, number of linear meters of pipe culverts replaced, number square meters of cracks sealed, etc.	Agreed intervention level of up-keep avoids the measuring of quantities, as payment is made based on standard of up-keep and deductions imposed from payment up on failure
4	Difficult & time consuming to justify the revision of quantities, contract revision / revised / working estimates, approvals, etc.	Greater responsibility on the contractor through out contract period. No need for modifying contract
5	Possible revision of contract values	No change in contract value till the contract is complete
6	Difficult to realize penalties	Easy for realizing deductions imposed from payment up on failure

## 6. GAINS OF RMMS

The road condition data collected for the development of the 2004-05 maintenance

program indicates that road conditions have improved considerably as shown in the summary of the 3 pilot districts presented in Tables 5 to 7.

**Table 5: Road Condition Rating of Rural Roads in Adilabad District**

S. No	Surface type	Good		Fair		Poor		Bad		Total Length
		Length	%	Length	%	Length	%	Length	%	
1	BT	312	44	233	33	159	23	1	0	703
2	CC	25	62	14	36	1	2	0	0	40
3	WBM	38	4	216	25	403	48	191	23	849
4	GR	67	11	326	53	196	32	30	5	619
5	ETH	0	0	19	3	58	8	668	90	745
	<b>Total</b>	<b>441</b>	<b>15</b>	<b>808</b>	<b>27</b>	<b>818</b>	<b>28</b>	<b>193</b>	<b>7</b>	<b>2956</b>

*Notes:*

BT - Bituminous surface; CC - Cement Concrete surface, WBM - Water Bound Macadam surface, GR - Gravel surface, ETH - Earthen surface

**Table 6: Road Condition Rating of Rural Roads in Karimnagar District**

S. No	Surface type	Good		Fair		Poor		Bad		Total Length
		Length	%	Length	%	Length	%	Length	%	
1	BT	188	3	323	55	82	14	0	0	593
2	CC	17	99	0	1	0	0	0	0	17
3	WBM	15	4	136	39	173	49	27	8	351
4	GR	28	4	358	47	310	41	65	9	762
5	ETH	0	0	0	0	2	2	122	98	124
	<b>Total</b>	<b>248</b>	<b>13</b>	<b>817</b>	<b>44</b>	<b>567</b>	<b>31</b>	<b>193</b>	<b>10</b>	<b>1847</b>

*Notes:*

BT - Bituminous surface; CC - Cement Concrete surface, WBM - Water Bound Macadam surface, GR - Gravel surface, ETH - Earthen surface

**Table 7: Road Condition Rating of Rural Roads in Warangal District**

S. No	Surface type	Good		Fair		Poor		Bad		Total Length
		Length	%	Length	%	Length	%	Length	%	
1	BT	152	16	716	76	78	8	2	0	946
2	CC	17	53	12	35	4	12	0	0	33
3	WBM	18	4	214	44	154	32	101	21	488
4	GR	28	6	209	44	184	39	56	12	476
5	ETH	0	0	8	5	14	9	135	86	157
	<b>Total</b>	<b>214</b>	<b>10</b>	<b>1159</b>	<b>55</b>	<b>434</b>	<b>21</b>	<b>295</b>	<b>14</b>	<b>2100</b>

*Notes:*

BT - Bituminous surface; CC - Cement Concrete surface, WBM - Water Bound Macadam surface, GR - Gravel surface, ETH - Earthen surface

The success of the Pilot Maintenance Project in Adilabad, Karimnagar and Warangal districts using programmed maintenance and two cycles of performance based contracting is clearly demonstrated by the following:

- Roads rated in good condition have increased from 4% to 35% in four years.
- Roads rated in poor condition have decreased from 56% to 18%.
- Roads which meet the required intervention standards have increased from 44% to 88%
- Average speed has increased from 15 km/h to 29 km/h
- Buses now ply up to 4 trips per day with reduced running costs and comfort to the passengers
- Increase in market transactions
- Major savings in maintenance costs
- Dramatic reduction in road user costs

The most major gains have been the extensive use of gravel resurfacing and exclusive use of bituminous emulsion for routine maintenance.

## 7. CONCLUSIONS

The following conclusions are drawn from the present pilot project of Rural Roads Maintenance in Adilabad, Karimnagar and Warangal districts of Andhra Pradesh.

- Systematic Road Maintenance Management System is essential for preserving rural road asset created and effective maintenance and serviceability.
- Performance based contracting is effective compared to conventional contracting.
- Well maintained roads have improved pavement condition, average speed, market transactions in addition to savings in road user costs.