

## **Maintenance of minor roads using the lengthman contractor system**

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### **Introduction**

The Government of Kenya constructed over 8 000km of gravelled rural access road using labour-based techniques and, following the success of this, decided to apply the same labour-based methods to the implementation and maintenance of selected minor roads. The use of individual contractors or lengthmen to undertake routine maintenance over specified lengths of road has been a recognised management technique for many years. However, the effectiveness of the technique over a long period has seldom been monitored in detail. This research aimed to establish initial maintenance productivity standards for lengthmen in carrying out routine maintenance on minor roads.

Routine maintenance, in this context, is defined as all work required within the road margin capable of being maintained by an individual lengthman contractor. Periodic maintenance of the roads includes regravelling and repairs to structures, and this is carried out by special units or contracting companies. Occasionally, emergency works are carried out under various arrangements when the scope is beyond the capabilities of the lengthman contractor.

### **Development of the maintenance system**

#### ***Principles of the approach***

Ex-construction workers were chosen as lengthmen on a contract basis to each section of road, typically 1.5-2.0km in length. He was provided with hand tools and supervised once a month by an overseer to monitor the condition of the road and to authorise payments for satisfactory work. The payment was based on the contractor carrying out 12 days of work per month on days of his choice. The contractor could be replaced if he performed consistently badly.

The contractor lived adjacent to the road and would therefore not require government accommodation or transport which consume considerable resources in a traditional equipment-based system. An attraction of the system is the comparatively low level of equipment required which considerably lessened support problems. This is coupled with a low foreign exchange component which, in 1981, was estimated to be only 10 per cent. This compares with a typical foreign exchange component for equipment-based routine maintenance systems of 50 per cent. The lengthman system also creates productive paid employment in rural areas where there are few employment opportunities. The contractor is able to live at home with his family and the part-time terms give him the opportunity to work on his own land as well.

Approximately 80 per cent of the direct costs of the system were estimated to be paid directly to the contractors in 1982. The system also enables maintenance to be achieved throughout the year on each section of road. The responsibility for the maintenance of each road section lies completely with one person who requires minimal logistic support.

#### ***Experience of operation***

It was found that the maintenance system did not attract the same level of interest as had the construction component of the programme. It was erroneously assumed that the local administration and people would bring pressure to bear on the contractors to maintain the roads to a good standard. The contractor's

appreciation of the maintenance requirements was taken for granted. The need for training and supervision was underestimated, and mechanical problems associated with the supervision vehicles had an adverse effect.

Although the lengthman system can be quite effective, there is a need for good direction and control of the contractors:

- In particular, there is a need to determine more accurately the maintenance requirements under various conditions of rainfall, alignment, pavement/soil type and traffic
- Methods of determining required maintenance resources and their deployment, direction and control need to be developed
- Arrangements for dealing with urgent works, such as wash-outs and culvert breakages need to be formalised
- The methods of identifying spot regravelling and full regravelling requirements need to be developed, and the various options for carrying out this work, *e.g.* by animal-drawn haulage and casual labour using small contractors, need to be investigated
- There is a requirement to ease the supervision burden of the maintenance overseers because of the minimal time that they can allocate to each contractor and the mechanical problems that will always exist to a degree, even with the low equipment component of the system
- The scope for use of headmen, responsible for a small number of contractors, needs to be developed, as well as methods of training, directing and monitoring them
- On the technical side, there is a problem of maintaining a satisfactory longitudinal profile especially for the wider, more heavily trafficked minor roads
- There is a question of the safety of lengthmen working on the carriageway of the more heavily trafficked roads (> 50 vehicles per day)
- Consideration needs to be given to the use of simple tractor-drawn mechanical graders or drags for maintaining the running surface in these circumstances; with pot-hole patching support and all off-carriageway work by the lengthmen

Although the lengthman system has been adopted for the maintenance of rural access and minor roads in Kenya, a number of major improvements to the system have been initiated or planned.

### **Establishment of maintenance productivity standards**

A study has been undertaken to investigate several aspects of maintenance using lengthmen contractors. Originally, activities were divided into 11 groups but, subsequently, five of these were sub-divided. Lengthmen were given daily tasks on various maintenance activities along a short section of road. Tasks were set daily by overseers and monitored throughout the day by both the overseers and the headmen. During the study, contractors were retained for approximately seven hours if tasks were not completed. However, they were released earlier, normally after five hours, if they finished their work satisfactorily. Individuals were rotated between activities on successive days. Four degrees of difficulty were defined for each maintenance activity, and some activities were broken down into two components for ease of control or measurement.

Productivities were calculated in terms of quantity of work completed per hour. These values were adjusted to represent the quantity of work that could be expected for a standard five hour working day where there was close supervision. Normal supervision ratios are eight headmen to 80 lengthmen in one district. In the study undertaken, three overseers each supervised 15 maintenance contractors with the assistance of two 'non-working' headmen. In some areas, 'working headmen' have their own maintenance section as well as supervision responsibilities over other headman. Thus, the results from the study reflect a higher level of supervision than would be the norm in this particular situation.

Little difference was observed in Productivities between age groups, districts or sexes. The most

significant observation was that contractors who finished their tasks, and thus left work early, worked significantly harder (up to 30 per cent) than those who failed to do so. This suggests a strong argument for establishing a task-based system with fair and achievable targets. The productivity results given in Tables 1 and 2 were obtained.

### Other factors

The following factors will also affect the performance of roads and, as a result, the Productivities to be used as targets:

- Traffic (< 20, 20-50, > 50 vehicles/day)
- Annual rainfall (< 500, 500-1500, > 1500mm/day)
- Vertical gradient (< 4, 4-8, > 8 per cent)
- Surface materials (gravelled, ungravelled)

Further work is on-going to determine these effects.

**Table 1 Productivity rates in a wet highland area**

Activity	Unit	Task difficulty				*Nature of difficulty
		1*	2*	3*	4*	
Clean culvert inlet	as shown	2-5 culverts/day (< 10)	1-1½ days/culvert (10 to 15)	1½-3 days/culvert (15 to 30)	3-5 days/culvert (> 30)	Culvert diameter silted
Clean culvert outfalls	m/day	45-60 (< 10)	30-45 (10-20)	15-30 (> 20)		Depth of silt (cm)
Repair culvert headwalls	No/day	5-10 (minor)	3-5 (major)			Type of repair
Clean mitre drains	m/day	50-65 (< 10)	35-50 (10-15)	25-35 (> 15)		Depth of silt (cm)
Clean side drains	m/day	55-75 (< 10)	35-55 (10-15)	25-35 (> 15)		Depth of silt (cm)
Repair scour checks	No/day	3-8 (wood)	5-9 (stone)			Type of scour check
Repair side drain erosion	m/day	90-110 (< 15)	70-90 ((15-30)	50-70 (> 30)		Depth of erosion (cm)
Repair shoulder erosion	m/day	85-110 (< 10)	60-85 (10-15)	40-60 (> 15)		Depth of erosion (cm)
Grass planting	m/day	90-110 (< 0.5)	70-90 (0.5-1.0)	60-70 (> 1.0)		Planting width (m)
Fill pot-holes in carriageway	w/barrows per day	23-30 (no haul)	16-23 (< 100)	11-16 (100-200)	7-11 (> 200)	Haul distance (m)
Fill ruts in carriageway	m/day	60-80 (no haul)	40-60 (< 100)	30-40 (100-200)	10-20 (> 200)	Haul distance (m)
Grub c/way edge	m/day	230-300 (< 0.5)	160-230 (0.5-1.0)	100-160 (> 1.0)		Width of grubbing (m)
Reshape	m/day	55-80	40-55			Type of

Activity	Unit	Task difficulty				*Nature of difficulty
		1*	2*	3*	4*	
carriageway		(< 75mm)	(> 75mm)			reshaping
Grass cutting (light)	m/day	400-450 (< 1.0)	220-300 (1.0-2.0)	150-220 (> 2.0)		Width of cut (m)
Grass cutting (dense)	m/day	275-350 (< 1.0)	200-275 (1.0-2.0)	150-200 (> 2.0)		Width of cut (m)
Bush cutting (light)	m/day	400-450 (< 1.0)	220-300 (1.0-2.0)	150-220 (> 2.0)		Width of bush (m)
Bush cutting (dense)	m/day	250-300 (< 1.0)	200-250 (1.0-2.0)	150-200 (> 2.0)		Width of bush (m)
<i>Note</i>						
Figures in parentheses under task difficulty is the degree of difficulty in the units indicated in the right-most column						

**Table 2 Productivity rates in a dry lowland area**

Activity	Unit	Task difficulty				*Nature of difficulty
		1*	2*	3*	4*	
Clean culvert inlet	as shown	2-5 culverts/day ( $< 1$ )	1-1 $\frac{1}{2}$ days/culvert ( $\frac{1}{2}$ to $\frac{1}{2}$ )	1 $\frac{1}{2}$ -3 days/culvert ( $\frac{1}{2}$ to $\frac{1}{2}$ )	3-5 days/culvert ( $> \frac{1}{2}$ )	Culvert diameter silted
Clean culvert outfalls	m/day	45-60 ( $< 10$ )	30-45 (10-20)	15-30 ( $> 20$ )		Depth of silt (cm)
Repair culvert headwalls	No/day	5-10 (minor)	3-5 (major)			Type of repair
Clean mitre drains	m/day	50-65 ( $< 10$ )	35-50 (10-15)	25-35 ( $> 15$ )		Depth of silt (cm)
Clean side drains (soft)	m/day	45-60 ( $< 10$ )	35-45 10-15)	25-35 ( $> 15$ )		Depth of silt (cm)
Clean side drains (hard)	m/day	25-35 ( $< 10$ )	20-25 10-15)	20-25 ( $> 15$ )		Depth of silt (cm)
Repair scour checks	No/day	3-8 (wood)	5-9 (stone)			Type of scour check
Repair side drain erosion	m/day	75-100 ( $< 15$ )	40-75 (15-30)	20-40 ( $> 30$ )		Depth of erosion (cm)
Repair shoulder erosion	m/day	85-110 ( $< 10$ )	60-85 (10-15)	40-60 ( $> 15$ )		Depth of erosion (cm)
Grass planting	m/day	90-110 ( $< 0.5$ )	70-90 (0.5-1.0)	60-70 ( $> 1.0$ )		Planting width (m)
Fill pot-holes in carriageway	w/barrows per day	20-30 (no haul)	14-20 ( $< 100$ )	10-14 (100-200)	7-10 ( $> 200$ )	Haul distance (m)
Fill ruts in carriageway	m/day	40-60 (no haul)	20-40 ( $< 100$ )	10-20 (100-200)	5-10 ( $> 200$ )	Haul distance (m)
Grub c/way edge	m/day	150-220 ( $< 0.5$ )	80-150 (0.5-1.0)	50-80 ( $> 1.0$ )		Width of grubbing (m)
Reshape carriageway	m/day	55-80 ( $< 75$ mm)	40-55 ( $> 75$ mm)			Type of reshaping
Grass cutting (light)	m/day	275-350 ( $< 1.0$ )	200-275 (1.0-2.0)	150-200 ( $> 2.0$ )		Width of cut (m)
Grass cutting (dense)	m/day	275-350 ( $< 1.0$ )	200-275 (1.0-2.0)	150-200 ( $> 2.0$ )		Width of cut (m)
Bush cutting (light)	m/day	400-450 ( $< 1.0$ )	220-300 (1.0-2.0)	150-220 ( $> 2.0$ )		Width of bush (m)
Bush cutting (dense)	m/day	250-300 ( $< 1.0$ )	200-250 (1.0-2.0)	150-200 ( $> 2.0$ )		Width of bush (m)
<i>Note</i> Figures in parentheses under task difficulty is the degree of difficulty in the units indicated in the right-most column						

