# UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA

# ROAD MAINTENANCE IN THE NIGER REPUBLIC

M. BAKO



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## ROAD MAINTENANCE IN THE NIGER REPUBLIC

*by*

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ABSTRACT

The Republic of Niger is completely land-locked and, as it has no railways and, at present, very limited water and air transportation, the roads play a major role in meeting transport requirements. As well as developing an adequate road network, it is therefore very important that the roads should be properly maintained.

This paper describes the routine and periodic maintenance required for both earth and bituminous roads and for drainage structures, and gives examples of typical costs. Details are given of the organisation of the Road Maintenance Divisions and of the Equipment Division, which has recently been re-organised to co-ordinate the planning, repair and maintenance of the equipment required for road maintenance. An analytical accounting system has been introduced to keep a check on all the equipment costs. Reference is made to the training of staff, the keeping of complete records and the need for instilling a sense of the value to the community of maintenance work.

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# ROAD MAINTENANCE IN THE NIGER REPUBLIC

by M. BAKO

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## 1. INTRODUCTION

The Republic of Niger, which is completely enclosed by other countries, has a surface area of 1,267,000km$^2$. Since there is no coastline, use is made in particular of the following ports:

- COTONOU, 1,057km from NIAMEY, with a railway line over 438km of the route.
- LAGOS, 1,440km from MARADI, with a railway line over 1,130km of the route.

  1,411km from ZINDER, with a railway line over 1,150km of the route.
- ABIDJAN, 1,667km from NIAMEY with a railway line over 1,145km of the route.

The population of Niger was estimated in 1972 as 4,243,000 inhabitants, corresponding to a density of 3.35 inhabitants/km$^2$. In fact this population is not evenly distributed. Some 20% of the total surface of the country lies south of the 300 isohyetal line and this area accommodates 80% of the population, the average density in this case being 13.4 inhabitants/km$^2$. There are long distances between the large conurbations, with an average spacing of 129km along the NIAMEY/ZINDER route.

There are no railway lines in Niger.

River transport is limited at present to local communications. However, there is good progress with a project to provide a river connection between GAYA and NIAMEY and on to the sea.

Air transport, although developing rapidly, only handles a small number of travellers and a limited amount of freight. In addition to the international airport at NIAMEY (surfaced runway, 2,570m long), there are 5 main aerodromes at ZINDER, MARADI, TAHOUA, AGADEZ and ARLIT.

Thus the roads play the major role in meeting transport requirements. They form a basis for the economic development and have a bearing on the social, cultural and political life of the country. It is accordingly necessary to develop a road system that meets the demands and to ensure that the network is properly maintained.

The table below, which is based on the price structure for certain products, illustrates the importance of transport for a country where all equipment has to be imported.

| | Petrol | Diesel | Petroleum Products | IPN | Angle-iron |
|---|---|---|---|---|---|
| 1. Cost FOB | 100 | 100 | 100 | 100 | 100 |
| 2. Cost CIF COTONOU | 120 | 122 | 120 | 114 | 114 |
| 3. Cost CIF APAPA | 117 | 118 | 117 | | |
| 4. Cost CIF NIAMEY | 312 | 307 | 303 | 153 | 152 |
| 5. Cost CIF ZINDER or MARADI | 364 | 354 | 345 | | |
| 6. Ratio 4/2 | 2.6 | 2.52 | 2.55 | 1.39 | 1.39 |
| 7. Ratio 5/3 | 3.10 | 3.00 | 2.95 | | |

It should be noted that:

- Petroleum products arriving at NIAMEY are 2.5 times more expensive than at COTONOU and on arrival at ZINDER and MARADI they are 3 times more expensive than at LAGOS.

- Angle-iron arriving at NIAMEY is 1.4 times more costly than at COTONOU.

## 2. THE ROAD NETWORK IN NIGER

The essential feature of the road network is the main east/west route going from the frontier of MALI to that of CHAD. Roads branch off this route to the south and the ports of the Atlantic coast and to the north towards certain conurbations. In fact, the roads form a herringbone pattern - see Fig. 1.

The roads are classified into two groups according to whether they are of general concern or whether they serve a particular district.

The total length of roads in the general category, which in principle is maintained by the central government, amounts to 6,910km. This total is made up as follows:

- 753km of bituminous roads consisting of
  296km with two traffic lanes
  457km with one traffic lane

- 2,850km of earth roads

- 966km of improved semi-permanent tracks

- 2,371km of unimproved tracks

Excluding the tracks, the road density is:

- 2,84 m/km$^2$ or 0.849 m/inhabitant

For the area lying south of the 300 isohyetal line, the density is:

- 14.22 m/km$^2$ or 1.06m/inhabitant.

## 3. ROAD MAINTENANCE - OBJECTIVES

The road network represents an important capital investment and it is of prime importance to conserve its value with respect to the aggressive action of the climate and motor traffic. The necessity for such action is clear to the road engineer but not always to the general public. For the period 1960 to 1972, the amount of capital investment for new road construction in Niger, amounted to 13 x $10^9$F CFA which is almost equivalent to the annual budget of Niger. As examples of cost it can be stated that:

- A km of bituminous-surfaced road costs between 13 and 17 million CFA francs.

- A km of earth road costs between 3 and 7 million CFA francs.

For a road to function properly, it must be kept in good condition and retain the characteristics corresponding to the service which it provides (profiles, strength of the road structure, etc). In this context, road maintenance is clearly important in the view of the user and general public (poor condition of the road resulting in increased transport costs with repercussions, for example, on the costs of certain prime and necessary products, etc).

There are two main categories of road maintenance:

- periodic maintenance which is carried out according to a specified frequency and which involves renewal of the wearing course in the case of bituminous roads or the re-laying of a certain thickness of laterite material in the case of earth roads (regravelling);

- routine maintenance which is carried out either on a day-to-day basis or at a frequency of less than once per year.

For earth roads which have not been built according to modern standards, it is also necessary to consider another classification, namely improvement maintenance where the object is to bring certain sections of the roads up to a better standard (straightening of bends, installation of drainage works, etc).

### 3.1 Periodic maintenance

3.1.1 Bituminous roads In this field our experience only goes back a few years so that it is not possible to come to any valuable conclusions.

a) The first bituminous road from MARADI to the frontier of Niger was built in 1955-56. Unfortunately, the supervision of the construction was such that it is not possible to draw any firm conclusions with regard to the renewal of the wearing course.

At the present time, the road is in a deplorable state over much of the route with a transverse profile corresponding to the letter W. The defects are due not only to failures in the surface layer but also in the base course and earthworks.

b) The surface of the road from SABONGARI to GAYA, built in 1960-61, began to give disturbing indications of fatigue towards 1970 and resurfacing ought to have been carried out at that time.

c) The surface of the road from NIAMEY to TONDIBIA (12km) built in 1960 was renewed in 1964-65 and this road is performing satisfactorily.

In the light of our limited experience, it can be stated that a road surface should be renewed at intervals of between 7 and 12 years, the frequency being a function of the type of traffic on the road.

The resurfacing is carried out, after sweeping, by the laying of a surface course consisting of 1.0kg of 400/600 cut-back and 10 litres of 8-12 mm chippings (Los Angeles coefficient approximately 30).

3.1.2 Earth roads The effects of traffic and climate (rain, wind) on the base result in a reduction in its thickness which can become incompatible with the good performance of the road. The object of periodic maintenance is to "resurface" the base, usually with laterite materials, so that the traffic loads do not result in complete destruction of the road.

The loss of material on earth roads can vary from 1.5cm to 2.5cm per year according to the nature of the traffic, the material used and the type of compaction. In a recent study, BCEOM assumed the following for the wear of an earth road:

| Traffic cars/day | Wear cm |
|---|---|
| 60 | 1.70 |
| 80 | 1.90 |
| 100 | 2.10 |
| 120 | 2.16 |
| 130 | 2.20 |

The frequency of regravelling can vary between 5 to 10 years according to the nature of the traffic on the road. The thickness of the material involved is of the order of 15cm.

From 1960 to 1972, we spent about $2 \times 10^9$ CFA francs regravelling, corresponding to about 15% of the amount spent on the construction of new roads.

The cost of resurfacing, depending on the distance involved in transporting materials, varies from 1 to 1.8 million francs per kilometre. The annual cost varies from 125,000 to 450,000F.

3.2 Routine maintenance

The nomenclature of the tasks defined by the Public Works Department of Niger is as follows:

| Task Number | Earth roads | Bituminous roads |
|---|---|---|
| Routine maintenance | | |
| 1. | Patching operations | Patching operations |
| 2. | Ditches and turnouts | Road edges |
| 3. | Corrugations and levelling | Unsurfaced shoulders |
| 4. | Maintenance of structures | Ditches and turnouts |
| 5. | Improvement maintenance | Maintenance of structures |
| 6. | Road signs | Road signs |
| Periodic maintenance | | |
| 7. | Regravelling | Reinstatement of wearing surface |

Thus routine maintenance involves 6 tasks but in fact No. 5 (improvement maintenance) is well outside the context of such maintenance.

For convenience, earth roads and bituminous roads will now be considered separately.

3.2.1 Earth roads

3.2.1.1 Patching operations This involves filling up, as they appear, troughs, depressions, potholes and ruts. The work is carried out with a lorry and a team consisting of a team leader, a driver and 6 to 14 labourers.

The teams load the materials on a lorry and subsequently distribute it on the roads. This material, generally lateritic, is extracted from and stockpiled in the quarry by a bulldozer.

According to the traffic, the location of the quarries and the type of road involved, a team maintains 30 to 80/100km of road, the mean length being 57km.

In 1972 the total number of teams distributed over the whole road network amounted to 73.

Since the work is a point-by-point operation and not a continuous process (unlike resurfacing operations), the rate of working is rather low, corresponding in terms of material used to 12 to 20$m^3$ per day per team. In 1972 a total of 194,180$m^3$ of material was distributed in 11,412 effective working days, an average of 17$m^3$ per day per team.

A regularly maintained road requires 60 to 80$m^3$ of material for patching operations per km per year.

The first statistical results that we have obtained suggest the following formula for the volume of material required per kilometre, as a function of traffic:

$$C = 50 + 0.16V$$

where $C$ = volume of material used per day in $m^3$

$V$ = traffic per day in PCUs.

This formula simply gives an initial indication for deployment of the teams.

Thus the following should be noted from the graphs of figures 2 and 3:

From Fig. 2

| | |
|---|---|
| RN 27 | $\frac{1}{2}$ team too few |
| RN 24 | 1 team too few |
| RN 25 | 1 team too many |
| RN 6 | $\frac{1}{2}$ team too much |

From Fig. 3

| | |
|---|---|
| RN 25 | 1 team too few |
| RN 16 | 1 team too few |

Expenditure per kilometre and per year for patching operations can be represented by the following formula:

$$P = 60{,}000 + 150\ V$$

3.2.1.2 Action against corrugation - levelling

a) Corrugation is a surface deformation phenomenon of unsurfaced roads. It appears as parallel bands perpendicular to the road axis. According to the results of a study made by BCEOM and published in a special edition of the journal "Construction" dated September 1955: "It is frequently observed that there is a slight inclination of the corrugations with respect to the normal to the road axis; it rarely exceeds $10^{o}$. The corrugations are normally spaced at intervals of 60-70cm, but the spacing can sometimes be as much as 1 metre. The peak to trough distance is generally 5 to 6cm but can exceed 10 and even 15cm on roads where the maintenance is particularly slack".

It is not our intention to discuss the different theories concerning the formation of corrugations. M G JEUFFROY has put forward a theory which attributes the phenomena to a "modulated surface wear, with horizontal movement of the displaced material".

The fact remains that corrugation is a phenomenon which is very disturbing for the traffic. Motorists, in trying to avoid resonant frequency, drive fast. This results in a loss of adhesion between the vehicle and road surface and accidents occur in the event of any false manoeuvres.

The most efficient action against corrugation is to surface the road.

Action against corrugation is taken by means of brushes pulled by 60/70 HP agricultural tractors. The most commonly used brush is that consisting of a triangular chassis fitted with 50cm lengths of cable (Fig. 4).

The chassis can be 3 or 4 metres wide according to the road involved. The cables have the following characteristics:

- 6 strands, 19 wires W 14/10
- Bright steel, 180/200 kg/mm$^2$
- Central metal core, preformed straight weave
- 19.5mm diameter

The cables on a brush are changed on average every 6 months. Excessive use of the cables results in their fatigue and the road is scattered with pieces of wire resulting in punctures.

In certain cases, as shown by Fig. 5, the brush consists of 6 tyres (size 10 x 22.5). This equipment is only used on a few roads.

The brush is used on one half of the road on the outward journey and on the other half on return. The speed of the tractor must be rather low and should take account of the depth of corrugation.

The frequency of brushing depends on the traffic loading. It can be made at intervals of 1 day (for the roads carrying the most traffic) to 7 days.

b) Levelling is done with a motor-grader and generally at the following times:

- 1 traverse at the beginning of the winter season with a view to facilitating the flow of water off the road surface
- 1 traverse at the end of the winter season to restore the road shape
- Exceptionally 1 or 2 traverses in March or April when, because of the hardness of the surface corrugations, the traverse of sweepers is ineffective on certain roads. It is recommended that, whenever possible, the use of a motor-grader be avoided during the dry season.

The average rate of progress with a motor-grader in 1972 amounted to 6.4km of road surface levelled per day.

The"anti-corrugation and levelling" task costs between 10,000 and 44,000F per km per year.

3.2.1.3 Maintenance of road structures First it is necessary to examine the different works (bridges, culverts, drainpipes and sills) and then to carry out any necessary repairs.

It is necessary to clean out culverts and drainpipes for them to function properly (sand, tree branches etc). During the winter, it is necessary after each rainfall to inspect the work and ensure that outlets are not obstructed by trees torn up by torrents.

Before the winter season, it is necessary to clear out water courses above and downstream from the road.

During the winter season, certain drainage sills become obstructed with sand and it is necessary, particularly after the first rainfalls, to remove this obstruction.

The maintenance of structures also involves reinstatement work, the construction of cut-off walls or trenches and action against undermining of bridge piles.

Each sub-division has a team for this work consisting of:

- 2 stone masons
- 1 carpenter
- 1 assistant carpenter
- some labourers

The maintenance of road structures costs on average 3,000F per km per year.

3.2.1.4 Ditches and turnouts The aim of this work is to drain the water off the road surface towards existing drainage structures or towards surrounding lower lying areas.

Ditches must be cleaned out or new ones cut, using a motor-grader, before the beginning of the rain season. These are difficult operations which must be carefully supervised by the section leaders, since poor workmanship can have serious results (ditches with the wrong slope draining water towards the road surface, for example).

3.2.1.5 Road signs This work involves maintenance of kilometre and road markers and of direction indicators. Deficiencies in the sign arrangements are made good where necessary.

The average cost of this operation for regularly maintained roads amounts to 2,500F per km per year.

3.2.1.6 Road improvement maintenance This task lies outside the context of routine maintenance. It includes the following operations:

- local straightening of the alignment
- straightening of certain bends
- widening of the road and shoulders
- diversions
- raising the level of certain road sections
- increasing the flow through certain drainage works or construction of new facilities (culverts, drainpipes and sills).

For a total of 1,220km of roads regularly maintained by the NIAMEY/DOSSO division, 3.37 million francs were spent on maintenance improvements in 1972. This corresponds to an average of 2,762F per km per year.

3.2.1.7 Costs Analysis of the accounts for 1972 gives the following results concerning routine maintenance by the NIAMEY/DOSSO division:

- Length of roads maintained 1,392 km
- Maintenance costs per km 110,918F

| | Per cent |
|---|---|
| - Per cent total cost for | |
| Patching operations | 71.42 |
| Ditches and turnouts | 3.40 |
| Action against corrugation and levelling | 18.48 |
| Maintenance of road structures | 2.20 |
| Improvement maintenance | 2.60 |
| Road signs | 1.90 |

The percentages quoted above show the predominance of patching operations (71.42 per cent). Two of the tasks, namely patching operations and action against corrugations including levelling, account in themselves for 90 per cent of the total cost of routine maintenance. The other tasks all have comparable weighting (2.5 per cent on average).

3.2.2 Bituminous roads

3.2.2.1 Patching operations - Edges of the roads Patching operations consist of attention to potholes and depressions. Cold bituminous mixtures are used. The quantities of material involved depend on the degree of surface wear and range from 0.1 to 1.3 tonnes per km per year.

On roads where the surface is only 3.50 metres wide, the impact of the wheels when vehicles pass in opposite directions or during overtaking operations results in damage to the edges of the road surface. Repairs are made with cold bituminous mixtures. The quantity of material used is a function of the amount of fatigue of the road surface and the maintenance applied to the earth road shoulders.

The cost of these two tasks for the road from NIAMEY to DOSSO amounts to 3,200F per km per year.

3.2.2.2 Unsurfaced shoulders For roads having a surface only 3.50m wide, vehicles travel on the earth surface when passing in opposite directions and during overtaking operations. This results in wear of the shoulders. It is accordingly necessary to carry out patching operations as part of the routine maintenance and to effect a general resurfacing every 3 to 4 years.

The cost involved for the road between NIAMEY and DOSSO is of the order of 150,000F per km per year.

3.2.2.3 Other tasks (ditches and turnouts, maintenance of structures, road signs) involve the same attention as for the earth roads.

In the case of the DND route, the cost amounts to 15,730F per km per year.

3.2.2.4 Costs The cost of routine maintenance of a bituminous road with one traffic lane, for the example considered, amounts to approximately 170,000F. It should be noted that attention to the shoulders is the most important item here, involving 88 per cent of the total costs.

For comparison it is estimated that routine maintenance of a surfaced road, 6 metres wide, will be of the order of 36,000F per km per year.

# 4. ORGANISATION OF ROAD MAINTENANCE

The proper execution of the road maintenance tasks depends essentially upon:

- the working units (Divisions, Sub-divisions, Sections and Teams) responsible for carrying out the tasks defined above;
- the Equipment Division responsible for supplying the working units with all the equipment required for execution of their tasks.

## 4.1 Staff Organisation

4.1.1 Teams The basic working unit is the team consisting of:

- 1 Team Leader
- 1 Driver with a 5/7 ton lorry
- 6 to 14 labourers with hand tools (shovels, picks and barrows)
- 1 tractor with brushes for corrugations, and driver (40% of the teams are not equipped with such tractors)

The team is responsible for routine maintenance of a specific section of road (30 to 80km).

In 1972 there were 73 teams each responsible, on average, for 57km of road.

The team leader completes a weekly report for each task (RMR 1 to 7 and 13 to 20). Given the limited education of the staff involved, "pictured" forms are provided. The reports are given at the end of the week to the Section Head concerned.

4.1.2 Sections The section includes a certain number of teams (3 on average) and is headed by a technician (BEPC qualification plus 1 year of training in a special school). In 1972 there were 21 sections, each responsible for the maintenance, on average, of 185km of roads.

The weekly reports from the teams are summarised in a monthly report by the Section Head. A copy of this document (RMR 8 and 21) is sent to the Head of the Sub-Division.

4.1.3 Sub-divisions The Sub-division is responsible for an area including a number of sections (3 on average, not including AGADEZ Sub-division) and is headed by a Public Works Engineer. The Head of the Sub-division is responsible, on average, for the maintenance of 555km of road.

The Head of the Sub-division prepares reports on a monthly, quarterly and yearly basis (RMR 9/22, 10, and 21/23). These reports are based on the monthly returns from the sections, which must be completed and evaluated.

The annual report by the Head of the Sub-division gives for each section and for each task:

- the number of kilometres
- the overall gross cost
- the gross cost per kilometre.

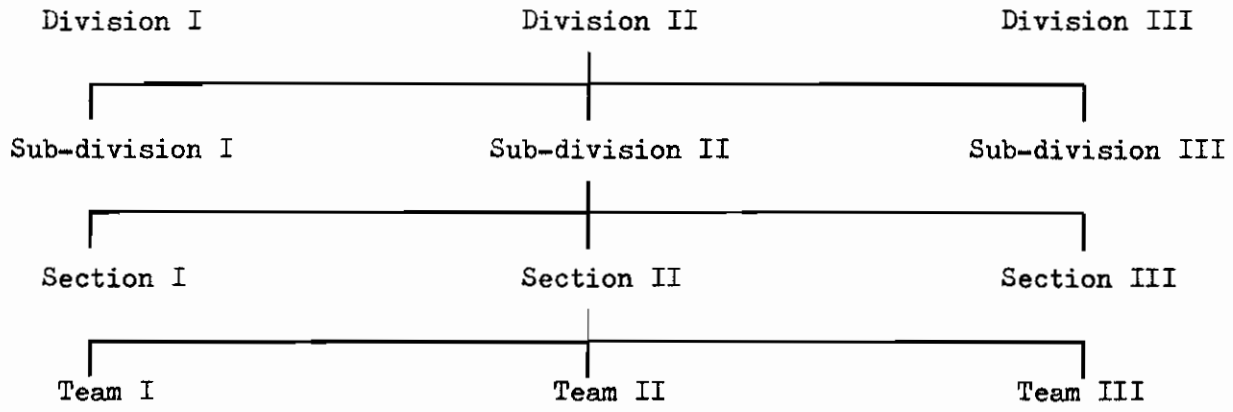
The report also gives for each section the overall gross cost per kilometre for the tasks as a whole.

4.1.4 Divisions The Sub-divisions are grouped into Divisions headed by graduate engineers. There are at the moment 3 Divisions for the whole country.

The Head of the Division prepares an annual report (RMR 12 and 24). This report gives the following information:

- the total cost of maintenance for a sub-division (gross expenditure plus overheads for the Sub-division)
- percent overhead costs for the Sub-division
- the average annual cost, gross and net, per kilometre and per road for each Sub-division.

The organisation of the working units is as shown below:



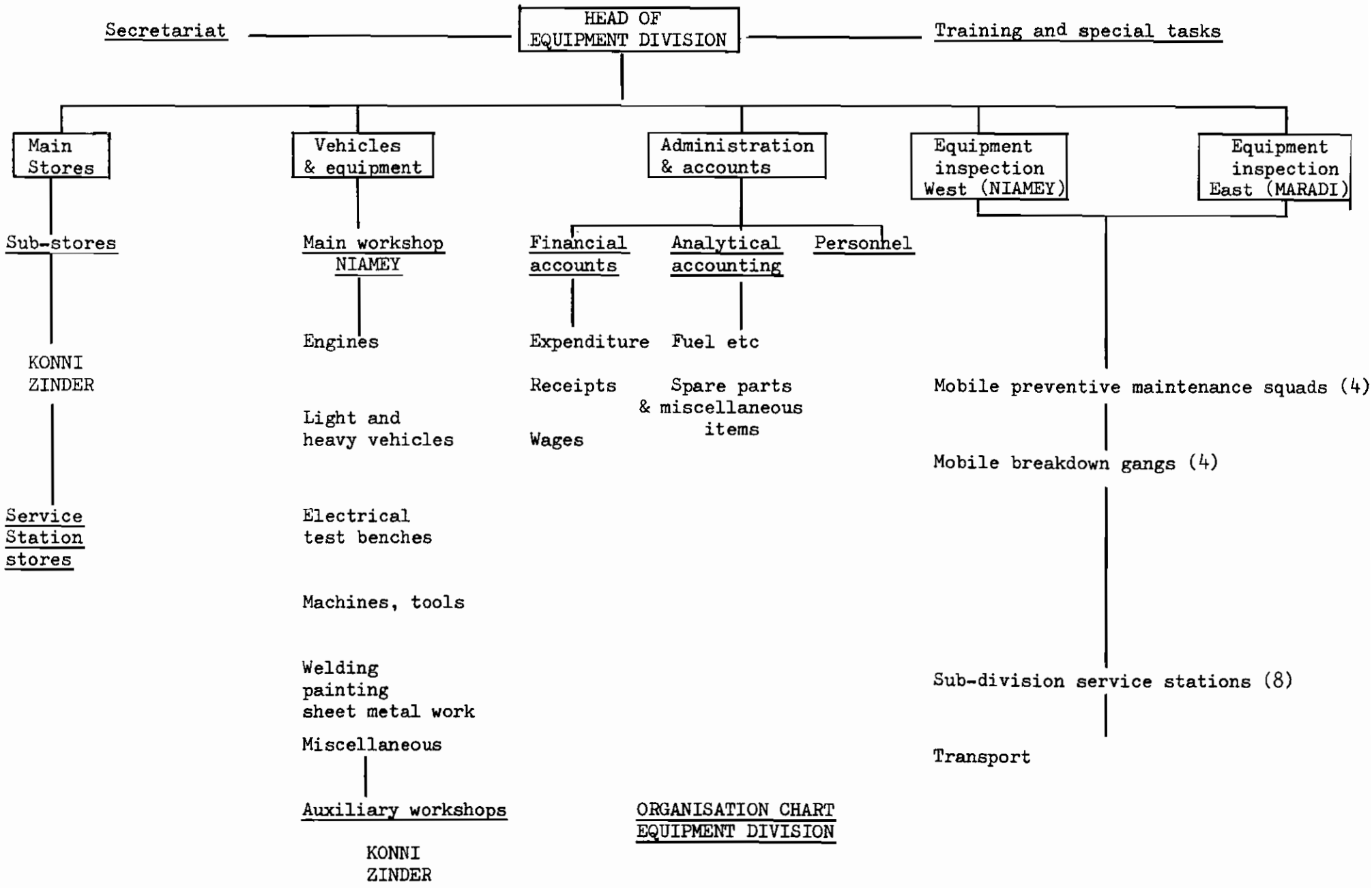

## 4.2 Equipment Division

This division is responsible for supplying the required mechanical equipment to the working units. Before 1970, the Equipment Division was only responsible for repairing heavy earth-moving equipment. Lorries, light vehicles and other equipment belonged to the Sub-divisions.

Since the reorganisation, all equipment belongs to the Equipment Division. The Division is responsible for the maintenance and repair of the equipment and hires items to the working units according to tariffs established by order of the Ministry of Finance.

4.2.1 Organisation of the Equipment Division The organisation of the Equipment Division is based on the following services:

- an administrative and accounting section (AAS) responsible for personnel, finance and accounts
- an equipment centre (EC) responsible for the maintenance and repair of equipment with main workshops at NIAMEY and two subsidiary workshops at KONNI and ZINDER
- Two equipment inspection sections based at NIAMEY and MARADI
- a stores section with a central facility at NIAMEY, 2 subsidiary stores at KONNI and ZINDER and stores at the service stations.




ORGANISATION CHART
EQUIPMENT DIVISION

4.2.2 Division of responsibilities The new organisation differs from the former not only with regard to the responsibility for equipment but also with regard to maintenance procedures.

Previously, each Sub-division maintained and repaired its equipment in its own workshops; there was no co-ordination or liaison and no standardisation. Now the work is carried out at different levels according to its importance:

- the equipment centre is responsible for all major repairs and general modifications (4th level)
- the subsidiary workshops are responsible for routine maintenance and standard replacements (3rd level)
- the breakdown and preventive maintenance gangs are responsible for work on equipment located at the work sites (2nd level - type A)
- the service stations are responsible for all routine maintenance operations and replacement of standard sub-assemblies as well as cleaning, greasing and oil changing (2nd level - type B)
- drivers are responsible for daily maintenance (1st level).

4.2.3 Cost analysis An analytical accounting system has been established with a view to determining equipment costs. This analysis is based on a knowledge of the costs of maintenance and repairs, the performance and functioning of transport and the depreciation involved. In addition to these direct costs, account must be taken of the operating costs of the Equipment Division, the Equipment Centre and subsidiaries, cost of maintenance and depreciation of buildings, cost of materials and fixed equipment. The direct costs are determined by preparing and making use of the following documents:

- request for action as a result of equipment inspection
- stores issue notes
- work cards completed by the workshops
- staff returns
- transport returns
- analytical records

4.3 Central service

The working and Equipment Divisions come together in a single service which is known as the Central Roads and Works Department.

## 5. CONCLUSIONS

As a result of experience in the Republic of Niger, it appears useful to emphasise the following points.

5.1 Importance of road maintenance

First it appears that every attention must be paid to road maintenance.

Certain people regard road services as an extravagant luxury and wish to reduce their cost to the bare minimum. It is necessary to explain to financial departments that investment in roads involves maintenance and that inadequate attention here can have serious consequences and in any case have results that are by no means optimum from an economic point of view. Recurrent charges must be taken into account from the beginning of any road construction project.

## 5.2 Training of staff

The training of staff is one of the major problems of the road services. The problem here is both quantity and quality and it is not easy to solve. The problem can be appreciated when it is considered that as part of the reorganisation of road maintenance we were obliged to recruit and train illiterate personnel. Thus it was necessary not only to train them as fitters but also to teach them to read and write.

The professional training must be continuous (revision courses, exchange of information, seminars etc).

In addition to the training of personnel there must be both moral and material motivation. The object here is to explain to personnel the importance of their work for the national community and at the same time to pay attention to material incentives.

The value of the profession to the community needs to be reassessed, taking account of the public benefit of road maintenance and the heavy responsibilities, at all levels, of those concerned. Thus a bulldozer operator is responsible for equipment which is worth about $15 \times 10^6$ F CFA and the least carelessness on his part can result in a large capital loss for the country.

## 5.3 Organisation and planning

It is necessary to organise road maintenance so that tasks are properly executed for the least cost. The different aspects to be considered, apart from the professional training mentioned above, are as follows:

- maintenance and repair of equipment as required for the road maintenance tasks. Analysis of our records has shown us that costs associated with equipment represent a large proportion of the total cost (between 65 and 78 per cent) whereas the percentage costs for personnel and for fuels and materials correspond respectively to 16 and between 16 and 19 per cent.

- there should be a good understanding between the working units and the Equipment Division and a collective appreciation of the importance of the joint execution of the work.

- a rigorous planning of the operations should allow efficient despatch of equipment which should not remain immobile and out of service. This planning should be established sufficiently in advance of the beginning of the financial year.

- there should be a sound knowledge of each road and its characteristics, of the different sites of material, the weaknesses, the type of soil, sources of water, conurbations, etc. There should also be an up-to-date record of the various works that have been carried out.

- there should be a system for collecting information and for analysing road maintenance costs.

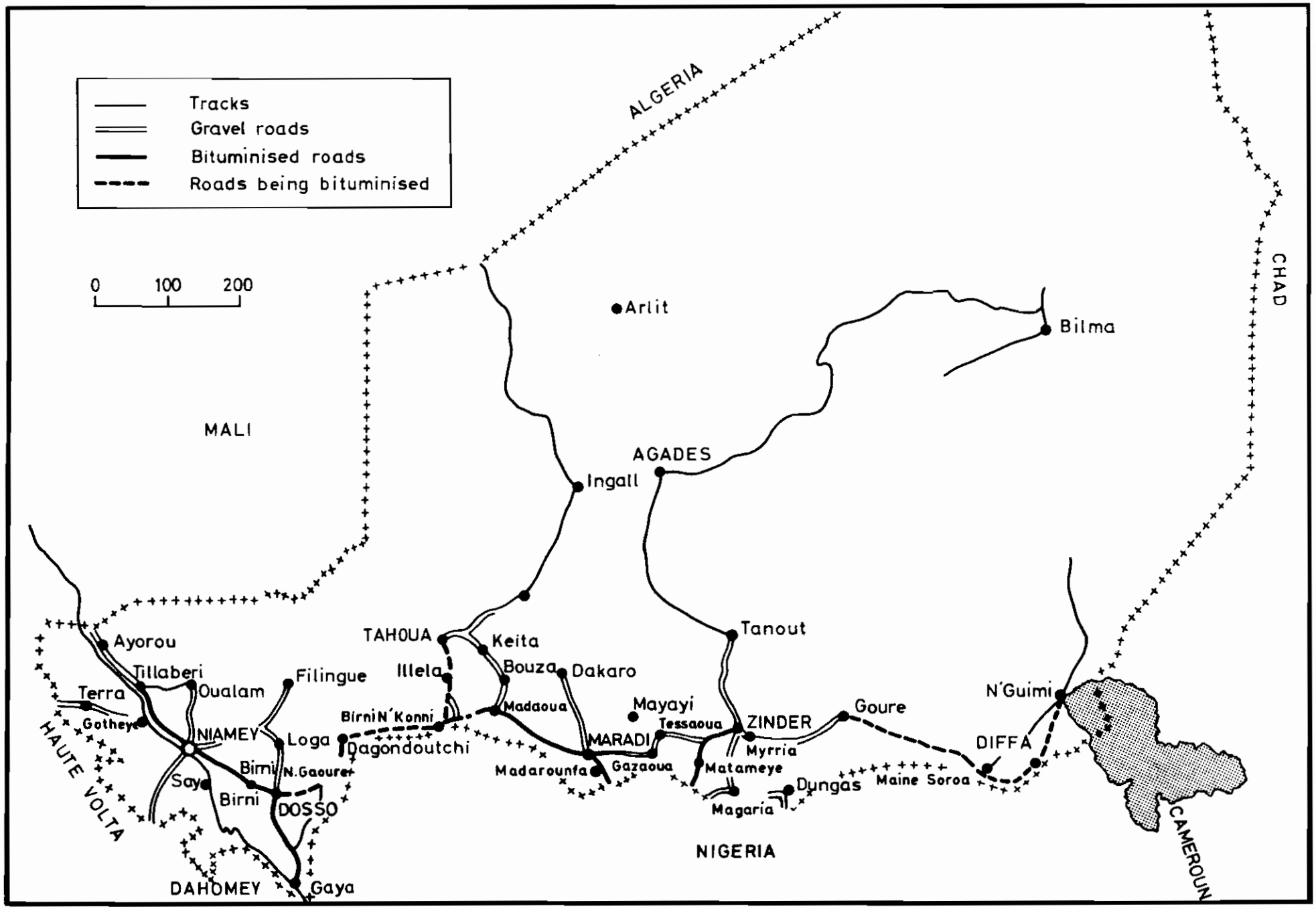



Fig. 1 ROAD MAP OF NIGER

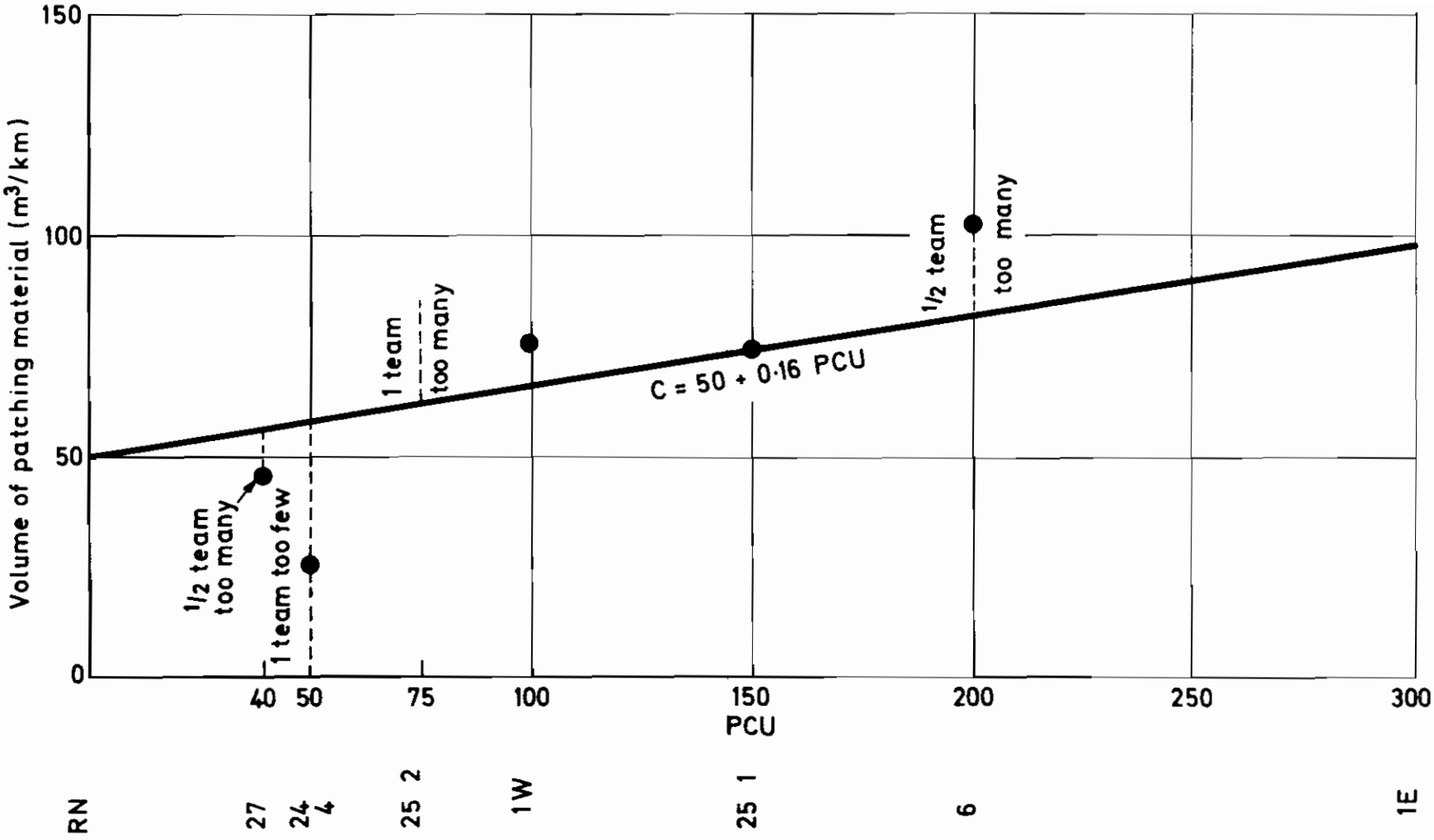



Fig.2 PATCHING MATERIAL IN RELATION TO TRAFFIC ( NIAMEY DOSSO DIVISION )

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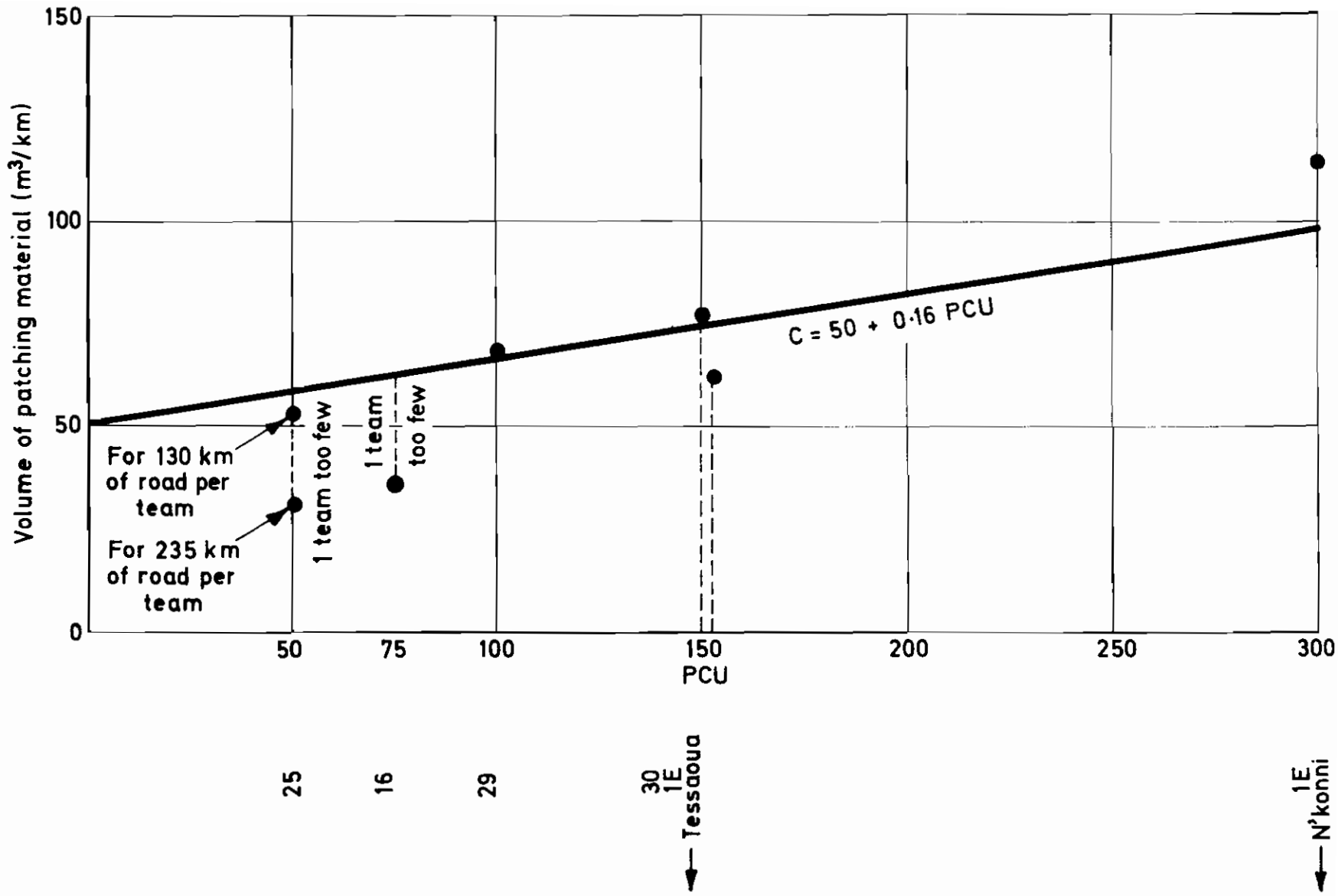


Fig.3 PATCHING MATERIAL IN RELATION TO TRAFFIC ( MARADI TAHOUA DIVISION)

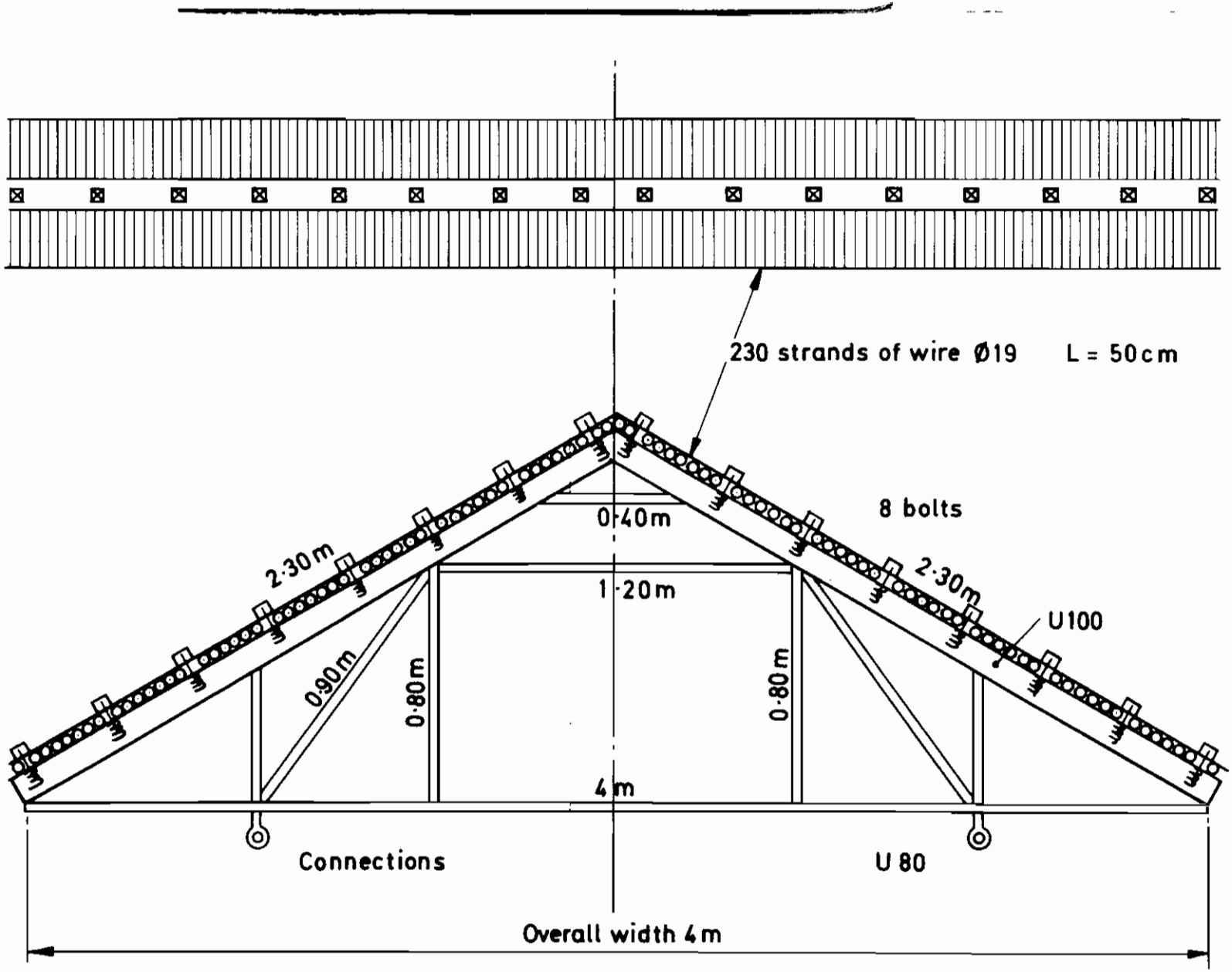


Fig. 4 DIAGRAM OF LARGE BROOM

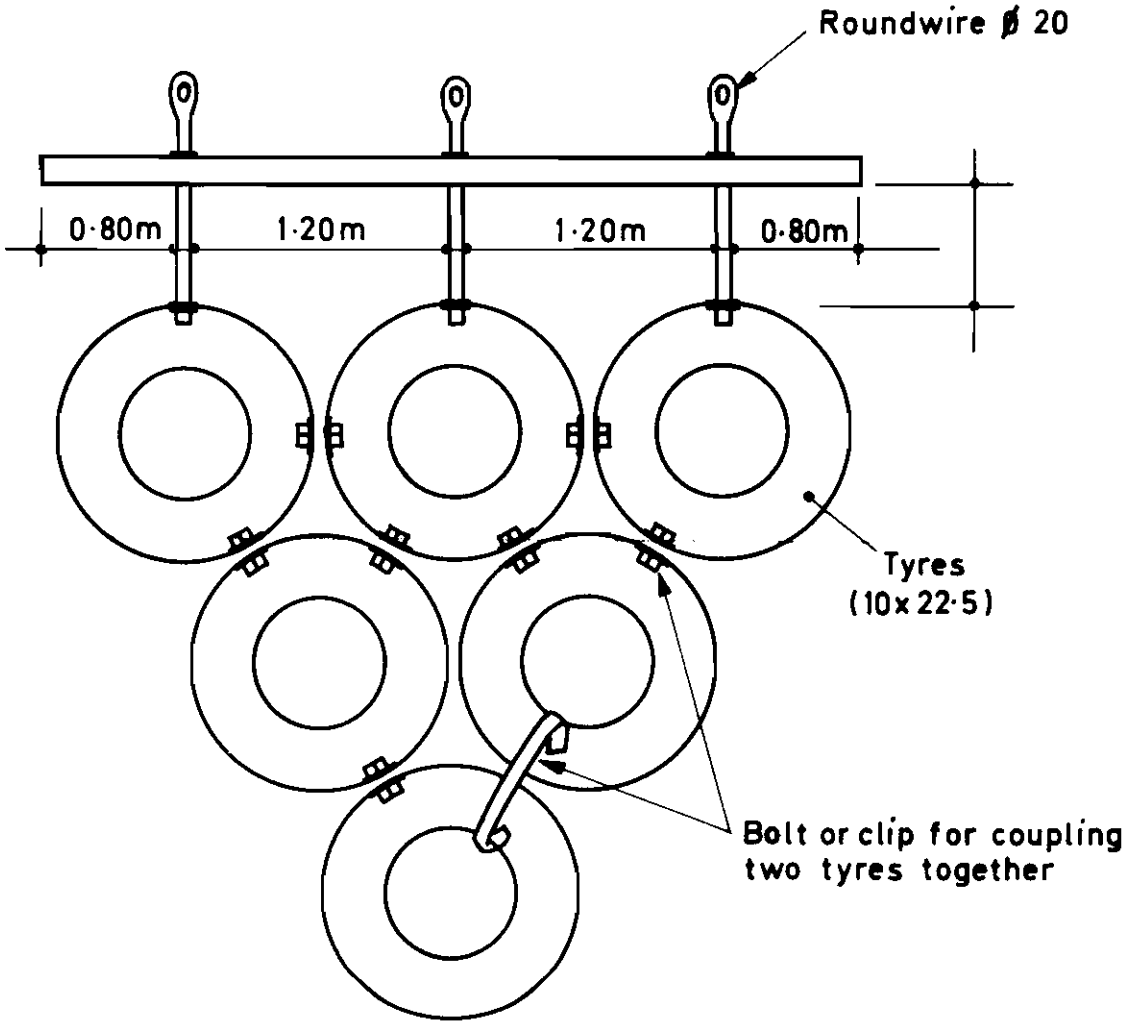


Fig. 5 DIAGRAM OF A TYRE DRAG