GEPUR: A Method for Managing a Road Network by and for Local Authorities

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Abstract: France has about one million kilometres of roads, 98% of which are managed by departments (the French Administrative Area Departement) and municipalities. Because of growing social expenditures, these local authorities are reducing credits for roads, which is leading to a reduction in the length of roads serviced annually, and an expected deterioration of roads generally. Faced with this problem, departmental and urban project designers in the eastern region of France have been meeting within the GEPUR ("Gestion et Entretien du Patrimoine Urbain et Routier" or "Urban and Road Heritage Management and Maintenance") group since September 2012, to: firstly, develop a method for road network management and programming of assistance based on the experiences of each participant, a modular method depending on the size of the road network and adapted to the contracting authority; secondly, give technical legitimacy to the managers who will be applying the method. They will be able to more easily set up a constructive dialogue with the elected officials in charge of roads, and better justify the use of the credits requested. Two methodological guides will be published, one intended for departmental networks (2015), the other for municipal networks in mid-2017. A white paper for elected officials has also been drafted. Ultimately, this experience will be extended throughout France.

Key words: Road network, road heritage, maintenance, local authorities, method.

1. Introduction

Over one million kilometers of roads are spread over France, 2% of which are managed by the state and 98% by departments and municipalities. To cope with the growing social expenditures, a number of contracting authorities are reducing credits for servicing roads, which is leading to a reduction in the length of roads serviced annually, and an expected deterioration of roads generally.

Faced with this problem, departmental and urban project designers in the greater eastern region of France have been meeting within the GEPUR ("Gestion et Entretien du Patrimoine Urbain et

Routier" or "Urban and Road Heritage Management and Maintenance") group since September, 2012, with two goals:

• firstly, develop a method for road network management and multiannual programming of assistance based on the experiences of each participant, a modular method depending on the size of the road network and the contracting authority's resources;

• secondly, give technical legitimacy to the managers who will be applying the method. They will be able to more easily set up a constructive dialogue with the elected officials in charge of roads, and better justify the use of the credits requested.

This article initially details the context of roads in France. It then presents the GEPUR group's initiative set up in the eastern region of France and its original features. The third part details the technical

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methodology deriving from the work of this group, proposed for both inter-urban departmental roads and urban roads.

2. The French Context

2.1 The French Road Network

In the early 21st century, the French road network comprises over a million kilometers of roads: 21,000 km belongs to the State, 378,000 km is of the responsibility of the departments, and over 660,000 km is managed by municipalities. As for today, this network today requires no further major developments, except for some expansions or improvements related to safety, traffic congestion or the opening-up of regions.

This very dense road network facilitates trade by road to and from everywhere in Europe, and contributes to France's economic attractiveness. From the standpoint of tourism, many roads in France contribute to this country's image: wine routes, ridge roads, waterfront roads, roads used in the Tour de France, etc. (Fig. 1). They also allow everyone access to services and culture.

This network represents a considerable financial value for each contracting authority, which is often underestimated. By way of example, the national road network alone, managed by the State, is estimated at €250 billion[1] or €12.5 million per kilometer [1].

2.2 Decreasing Servicing Credits

On the grounds that road networks mainly appear to be in good condition, the credits available for road maintenance are steadily diminishing, to be reallocated for social issues. In fact, the main interurban network, with high levels of traffic, built or rehabilitated over the last forty years, is quite well maintained. But the secondary interurban network, deriving from the historical network and essentially consisting of carriageways with a granular base, has

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[1]This figure includes the total cost of roads (carriageways, engineering structures and equipment).

less traffic, and maintenance work on it is variable; for this reason, some low-traffic roads are in poor condition (Fig. 2).

The same is true for urban networks, for which the quality of use varies. Infrequent renewal of the surface layers, interventions by concession-holders, and the complexity of roadworks in an urban environment are causing the structures to deteriorate well before the end of their planned service life.

Therefore, French departments reducing expenses dedicated to roads means that the actual renewal rate of the surface course is only of 4% to 8%, which indicates a service life for these courses of between 12 and 25 years. This theoretical service life is incompatible with the durability of current techniques, which is closer to 8 to 12 years (although it may be up to 20 years or more on roads with little traffic). If the current rate of renewal of the surface course is maintained as it is, the road network can only deteriorate in the medium term.

Fig. 1   Tourist road.

Fig. 2   Damaged road.

This deterioration will affect the surface course and the quality of use of the carriageway, and will quickly start to cause safety problems for road users, such as damage and slipperiness. But it will damage the structure itself by accelerating damage to the base courses. Repairing base courses, which are situated deeper, is more expensive than renewing the surface course alone, and the reduction in maintenance allocations today has the direct consequence of postponing rehabilitation work and laying that burden on future generations.

These risks are lower in towns, because the less aggressive traffic satisfactorily allows for surface course service lives of close to twenty years or more, not counting work on service networks.

This reduction in credits attributed to road maintenance has a direct impact on jobs, mostly local ones. Road maintenance relies on national or local road companies, whose branches, spread throughout the country, provide work locally, including for the low-skilled. The decline in maintenance today is causing road companies to lay off personnel and postpone investments in equipment, through the lack of visibility that multi-year maintenance programmes could provide.

Finally, the state of roads is the first impression that users perceive of the local authority as manager, and upgrading a road is considered by the user as a show of attentiveness by the contracting authority.

2.3 A Difficult Dialogue between Politicians and Technicians

This vision of the current situation and its likely evolution is shared by all technical players, who are project designers or works contractors.

But politicians who decide on budgets and vote them in the name of the local authority face many, often complex requests with conflicting philosophies and interests. They do not always have technical competence in the field of roadways, nor the factual information allowing them to make their decisions in full knowledge of what is at stake.

While the project management services of the larger local authorities have a large staff and sufficient means to define and justify their maintenance policy, the same is not true for the services of smaller local authorities for whom the exercise of dialoguing with policy makers is more delicate. These project managers often find themselves isolated, aware of the challenges they have to face, without having the tools to convince their superiors of the resources to be mobilized in order to prepare for the future and avoid problems that might arise.

3. The GEPUR Group

3.1 Creating the Group

This situation was worrisome for all those involved in the field of roadways, from project designers to contracting companies via consulting firms and professional associations, grouped within the IDDRIM.[2]

Encouraged, then, by the representatives of the entire road transport industry, the leaders of Cotita[3] Est prompted the creation of the GEPUR group (Gestion et Entretien du Patrimoine Urbain et Routier (Urban and Road Heritage Management and Maintenance)) in the fall of 2012. The representatives of the contracting authorities of the departments and towns in the Eastern France, covering ten departments (Fig. 3), were invited to take part and define their own methodology for maintaining their road networks, within a single group led by a representative of Cerema.[4] Seven of the ten departments called upon and six of the fifteen towns invited are working

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[2]IDRRIM: Institut Des Routes, des Rues et des Infrastructures de Mobilité (Institute of Roads, Streets and Mobility Infrastructures).

[3]Cotita: conférence inter-départementale sur les infrastructures de transport et leur aménagement (inter-departmental conference on transport infrastructure and improvement).

[4] Cerema: Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Centre for Studies on Risks, the Environment, Mobility and Urban Planning).

Fig. 3   GEPUR Group work zone.

assiduously in the GEPUR group.

3.2 Goals of the GEPUR Group

The primary objective of the GEPUR group is to enable managers in charge of departmental and urban networks to adopt an approach for managing and maintaining roads better suited to the way they work. Officers in charge of the daily management of road networks have technical knowledge that should be made use of and valued by means of a single, shared methodology, which can then be implemented seamlessly on contiguous networks.

A second, no less important objective is to give more legitimacy to every technician in the eyes of his decision-makers. Each technician can argue that his proposals are the result not only of his work and opinion, but of an approach shared with other professionals in the region.

3.3 An Original Way of Working

The working method adopted by the GEPUR group is original in the French context.

The presence in France of a network of laboratories and technical services serving the MEEM (the ministry in charge of roads and transport), working primarily in the construction and management of the national road network, led to technical documents being written by specialists from these services, for the benefit of the entire road community. While this exercise is relevant for many applications independently of the type of road being built and the way it is used (materials, conditions of implementation and design method), it is less so for managing a network, which is closely related to the policy of the contracting authority and its resources. In addition, the changes in society have led to doctrines no longer being drawn up top-down, by "knowledgeable" people enacting rules to be subsequently applied by subordinates; today this is done in a broader way, involving all players in the chain, each being a depository of the knowledge that should be mobilized in order to develop a methodology that includes all knowledge on the subject.

The GEPUR group is in line with this philosophy in that it mobilizes the skills of managers working closely with the subject on a daily basis, at the interface between roads and decision-makers; having the group led by a specialist in the field of roadways from Cerema makes it possible to provide the missing technical information (inspection equipment and methods, state-of-the-art, etc.) by mobilizing skills as required.

Moreover, the GEPUR group addresses both urban and inter-urban networks. Managing an urban road network has special features as compared to an inter-urban network:

• it is made up of different objects: streets, parks and squares, pavements and parking areas, cycle paths, and lanes dedicated to public transport;

• apart from the main network and public transport routes, its traffic is not very aggressive;

• work done by concession-holders on water, gas and communications networks weakens the pavement structure in place, reducing its initial service life;

• the quality of work in urban environments is lower than in rural areas, because of having to work in difficult conditions (confined space, limited time, the neighbourhood);

• a street may be rehabilitated for reasons other than those related to its wear (especially urban development).

For all these reasons, it has become necessary to work within GEPUR, partly with all its members in order to compare experiences for the benefit of all, and partly between inter-urban network operators and urban network operators, on the grounds that the philosophy is different.

Every three months, a full meeting enables progress of the work to be presented to local representatives of construction companies and their opinion to be sought (on an advisory basis only). For their part, companies are asked to provide answers in terms of maintenance techniques.

4. Initial Inventory

4.1 Surveys

Three successive surveys were carried out to establish an inventory of local practices and the expectations of those involved:

• the first was addressed to managers, asking them what tools they had to help them understand their road network, assess its condition, make a diagnosis and schedule maintenance operations;

• a second survey addressed to these same managers asked them to define their expectations in regard to contracting companies;

• a third and final survey questioned companies about how they perceive the way customers define their orders.

All the information gathered and processed anonymously was grouped together in a summary document, portraying local practices at the beginning of the study.

Of the large amount of information obtained, the most emblematic aspects are summarized below.

4.1.1 Survey No. 1: Managers' Tools and Practices

On the state of practices (Survey No. 1), seven of the ten departments in the action zone and ten towns out of the fifteen questioned responded to the survey (Table 1). The departmental services responsible for inter-urban road networks appear to be on average slightly ahead of the town services in charge of urban networks. They have more staff and more and more resources, managing a large network (3,680 km for average inter-urban networks, against 375 km for urban networks with a lot of disparities, Fig. 4). Documents defining the project management strategy in their network were drafted and approved by the assembly of elected representatives for 71% of departments, against 40% of towns. Regarding management tools, all departments have a database, while only 60% of towns have one; diagnosis tools are installed in 60% of towns and in only 43% of

Table 1   State of tools for the management of a road network (Survey No. 1).

Existence of tools for	Departments:	Towns
Number of responses	7	10
Validated strategic document	71%	40%
Data bank	100%	60%
Diagnosis tool	43%	60%
Programming tool	57%	30%

(a)

(b)
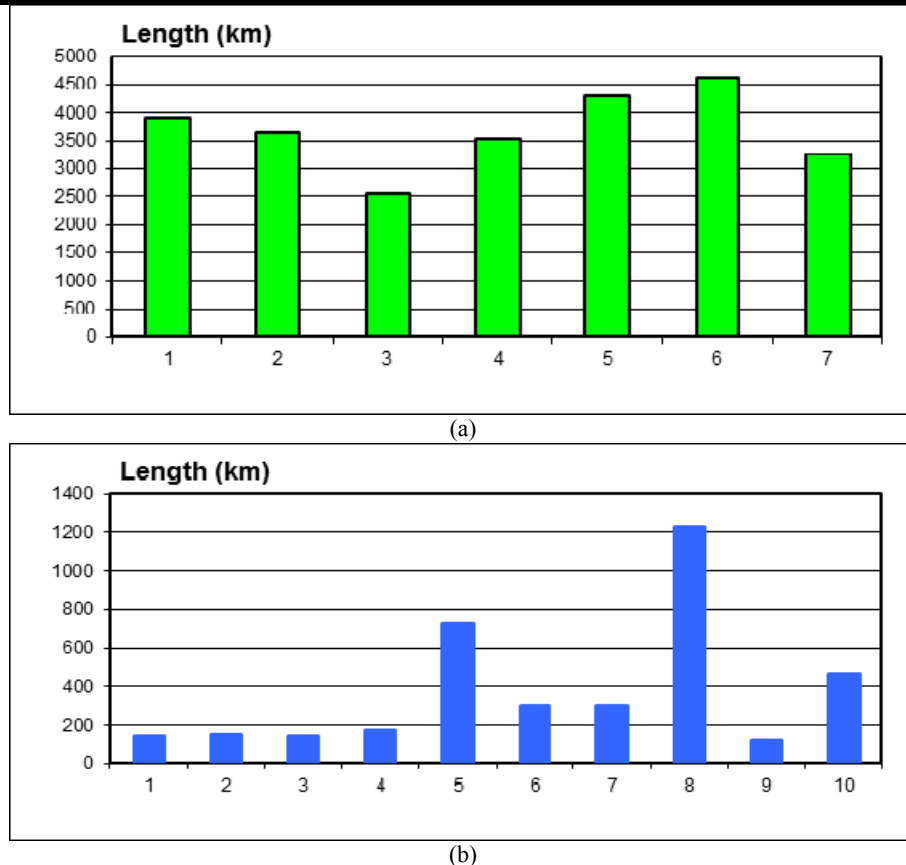
Fig. 4   Length of road networks managed by services that responded to Survey No. 1: (a) inter-urban network: 3,686 km on average ; (b) urban network: 375 km on average .

departments; 30% of towns have a work programming tool, against 57% of departments.

Diagnosis and programming tools for the work stated above are either business software (rare), or more frequently tools developed by the staff themselves. It is worth noting that in France, there are currently few diagnosis and programming tools: a very powerful tool called GiRR, developed for the national road network, is known but not widely used as it is perceived as being complex to use; a second lighter tool, dedicated to networks between municipalities is not well known and not mentioned in

the survey. This also explains the fact that departments report having programming tools without having diagnosis tools: in fact, the programming tools used include a diagnosis and prioritization phase, without any prior formalization.

4.1.2 Survey No. 2: Managers' Requests to Companies

Requests made by managers to companies (Fig. 5) focus on innovative solutions to ensure better durability. The questionnaire asked project designers to rank the themes that seemed important from a proposed list from 10 to 1 in descending order; the
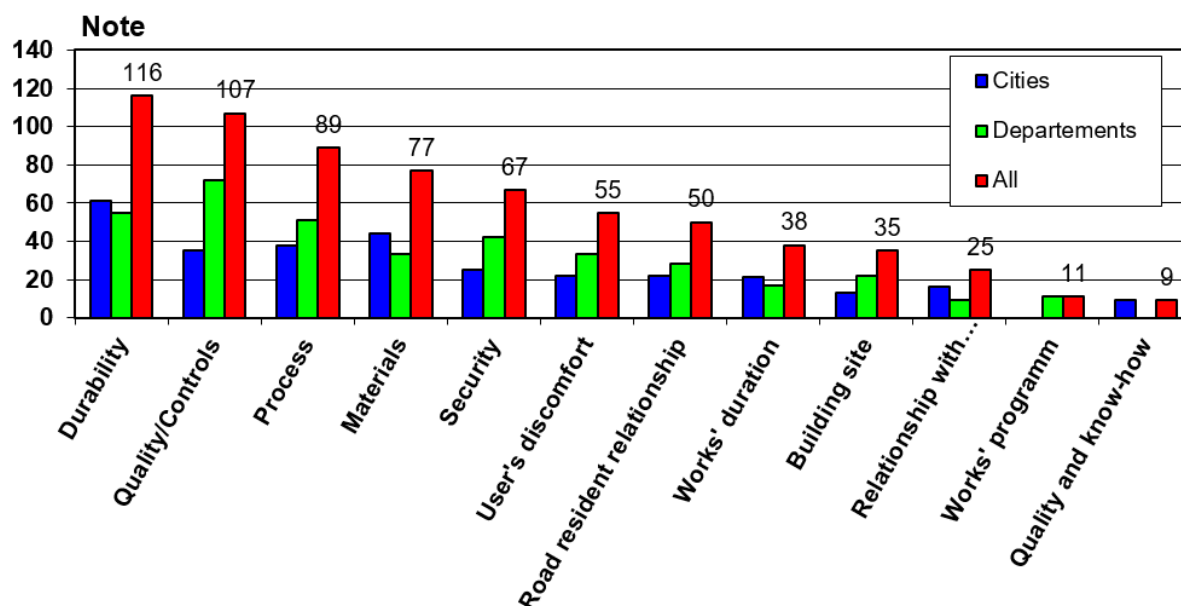
Fig. 5   Managers' requests to companies (Survey No. 2).

Traffic classes	T5	T4	T3	T2	T1	T0	TS	Total (km)
number of trucks/day 0		25	50	150	300	750	2000	
2x2 lanes mean lenght (m)				7				68,0
bituminous pav.					34,0	6,0	10,0	50,0
rigid pav.					12,0	6,0		18,0
flexible pav.								-
2 lanes (6 à 7m) mean lenght (m)				6,5				955,0
bituminous pav.		122,0	324,0	284,0	51,0	63,0		844,0
rigid pav.					74,0	37,0		111,0
flexible pav.								-
2 lanes (<6m) mean lenght (m)				5,3				2 638,0
bituminous pav.								-
rigid pav.								-
flexible pav.	1 000,0	1 000,0	638,0					2 638,0

Fig. 6   Example of a description of an inter-departmental network by type of carriageway and traffic class.

ranks assigned to each of the listed topics were added together to obtain a total score. Top of the list was performance over time for the solutions implemented, followed by the quality of the work to ensure this durability, followed in the third place by new processes to meet this durability requirement.

4.1.3 Survey No. 3: Companies' Requests to Managers

For their part, the essential request made by companies is that of improved visibility over the managers' orders, if possible over several years, so as to organize

the recruitment and training of new staff, and plan for equipment renewal. The current situation is resulting in staff reductions through lack of orders, and a reduction in investment.

The loss of technical competence that goes hand-in-hand with the diversification of contractors following the withdrawal of the state as a prime contractor for small towns is also frequently mentioned.

4.2 Knowledge of the Road Network

Drawing up an initial inventory assumed that every

project manager could describe his road network, dividing the total length by road type (dual carriageways, roads with a single lane each way over 6 m wide and roads less than 6 m wide), type of structure (soft, thick bituminous, semi-flexible) and traffic class (Fig. 6).

The exercise was conducted more or less easily depending on the manager, for two main reasons: firstly, the types of structure and the traffic class are not known everywhere in the network, mainly for low-traffic carriageways; secondly, urban networks are made up of streets, car parks and squares, cycle paths, bus lanes, and parking areas, that diversify space and complicate the census (a special section was dedicated to these). The exercise was carried out by making simplifying assumptions adopted by each manager for his own network.

Based on this detailed description, an estimated cost of full reconstruction was made for each network. Each section of the network, described by its type and traffic class, was associated with the new structure appearing in the appropriate official catalogue of new structures [2-4]. Knowing the required thicknesses and the average cost of implementation by material type in Eastern France, it was possible to estimate the cost of full reconstruction of the pavement structure alone for the section under consideration, and as a result, estimate the overall cost of full reconstruction of the entire network. As an example, the exercise carried out for a departmental network of 3,600 km of inter-urban roads led to an estimated €680 million for full reconstruction of its structures alone, not counting earthworks, road shoulders, drainage, equipment and civil engineering structures.

5. Method for Managing a Road Network

The main objective of the GEPUR group is to draft a methodology allowing a manager to optimize the maintenance of his urban or inter-urban road network. The approach proposed by the inter-urban network guide is described below.

5.1 Hierarchical Organisation of a Network

The first stage of the proposed approach is to prioritize the road network by classifying all roadways in the network into three or four categories. This classification is made in stages by defining:

(1) the expected functions for each roadway or section of roadway;

(2) the criteria that characterize these functions;

(3) the classification rules;

(4) the classification by road category.

In this way, the contracting authority defines a number of "functions" (or objectives) that a road must meet. By way of example, this may be: (1) bringing the most remote areas closer together by improving connections in particular in areas with heavy traffic; (2) ensuring access for local economic hubs to the major European networks; (3) promoting the development of tourist and historical sites, etc.

For each function, a "criterion", as a qualitative or identifying expression of the function, will then be defined. For example, bringing an isolated area nearer will involve locating "inhabited" areas (number of inhabitants greater than...), access to an economic hub (or a tourist area) requires the identification of an industrial or activity zone (or a particular site), etc.

The choice of functions and criteria depends on the local authority concerned.

The next step is to define the "categories" of roads, linking a set of functions and associated criteria to each of them. A road will belong to a certain category, if it corresponds, for example, to at least three of the associated criteria.

Finally, all roads in the network can be distributed over categories defined in this way. The exercise is validated by a mapping plan of the classification, to approve its relevance to the demographic, economic and tourist, mapping a cartography of the community, and if possible, in relation to neighbouring networks.

5.2 Level of Service

Defining a level of service for each route is one of

the key steps of the approach.

The level of service of a road is defined by a status assigned to different "fields" of the road. The fields identified are as follows: carriageway, horizontal markings and vertical road signs, green areas, drainage, shoulders.

Each field is characterized by "basic indicators" to be assessed. For example, for the field "carriageways", one can assess the indicators "crazing in the wheel path", "longitudinal cracks", "rutting", etc.; for the field "shoulder", the indicator "difference in carriageway edge level" can be assessed. Indicators are selected so that they can be identified either with high-performance instruments, or manually by specially trained officers.

The basic indicators are then classified into three "states": State 1: good; State 2: medium; State 3: poor. Each state is bounded by minimum and maximum indicator values. For example, for the indicator for longitudinal cracks, State 1 corresponds to less than 10% of the length affected, State 2 between 10 and 50%, State 3 over 50%.

The contracting authority then defines "quality objectives", distributed over four levels Q1 to Q4, which are determined for each field: each quality objective is described by the state of each of the basic indicators. For example, quality objective Q1 corresponds to State 1 for all indicators and objective Q4 to State 3; objectives Q2 and Q3 can adopt various states depending on the indicator.

The level of service is then defined by assigning a quality goal to each field.

5.3 Asset Evaluation

Evaluation of a road network is performed conventionally. It must make it possible: (1) to assess its condition at time t; (2) to account for the impact of road policy; (3) to periodically measure the levels of service achieved in the carriageway field.

To achieve this, contracting authorities can use either solutions based on high-performance devices (methods which are expensive and sometimes difficult to implement over time for relatively impoverished local authorities) or simplified practices developed locally that can even be implemented in-house.

Whatever the method used, it must be reproducible to enable reliable monitoring of the evaluation over time. This reproducibility is guaranteed by compliance with technically proven procedures, and by training the officers involved.

Periodic inspection of the network allows the manager to have an updated picture of the state of each of the sections inspected. The frequency is set to optimize the cost of inspection as compared with the benefit that derives from it. A frequency of three to five years is recommended, depending on the type of carriageway and the importance of the route.

This picture of the state of each of the network sections can be translated into one or two scores (for example, a score describing the state of the surface and a score describing the structural condition of the carriageway), or be used as is.

5.4 Maintenance Techniques and Strategies

The different maintenance techniques available in France are explained in a fact sheet in the appendix to the guide, describing the technique, its scope, its environmental impact and its limitations for use in the eastern region of France (especially its use and behaviour in winter). They are classified by family: routine maintenance, preventive and corrective maintenance, and rehabilitation techniques.

Next, the principles and benefits of routine, preventive and rehabilitation maintenance are explained, especially their impact on the service level of the carriageway. Typical scenarios are proposed, which are intended to be used for learning purposes. For example, while it is relevant and compulsory to perform routine maintenance (crack bridging, automatic patching), it cannot maintain the quality of use of the carriageway at the same level indefinitely; it will eventually deteriorate, because the carriageway

requires a thicker maintenance layer after three or four routine maintenance cycles (Fig. 7).

5.5 Budget Preparation

The budget is prepared iteratively between the management service, its local branches, and the representative of the contracting authority responsible for the maintenance budget.

From the picture of the network status, deriving from the periodic inspection and the level of service defined for each of the sections of the network, the manager identifies the sectors needing to undergo routine maintenance or preventive maintenance, and those requiring curative maintenance or rehabilitation. For the sections requiring rehabilitation, a study is commissioned, which will define the work required in year n + 1. For each section, a technique is then chosen, based on the policy set by the contracting authority according to the level of service determined.

This provisional programme of work can then be costed.

Depending on the available budget voted by the local authority, the programme deriving from a technical analysis must be adjusted, usually downward. Four solutions are possible: (1) road sections are withdrawn from the provisional programme (which means reducing the quality of use of a number of these sections, Fig. 8); (2) other less expensive maintenance techniques are adopted to maintain the length of road serviced (Fig. 9); (3) the distribution of roads by category is changed (which amounts to decommissioning a number of roads); (4) the level of service for a given road category is changed (which amounts to reducing the average quality of use of the network). This exercise is iterated until a technical and financial balance is struck.

The usual practice is to opt for Solution 1 (withdrawing sections from the provisional maintenance programme), which amounts to running a policy on a short-term, case-by-case basis. Managers today are moving towards Type 2 solutions, requiring finer, cheaper and more durable maintenance techniques from companies. The guide offers them Type 3 and 4 solutions, which involve opting for a comprehensive debate on the network maintenance policy over time that is consistent with the local authority's budget.
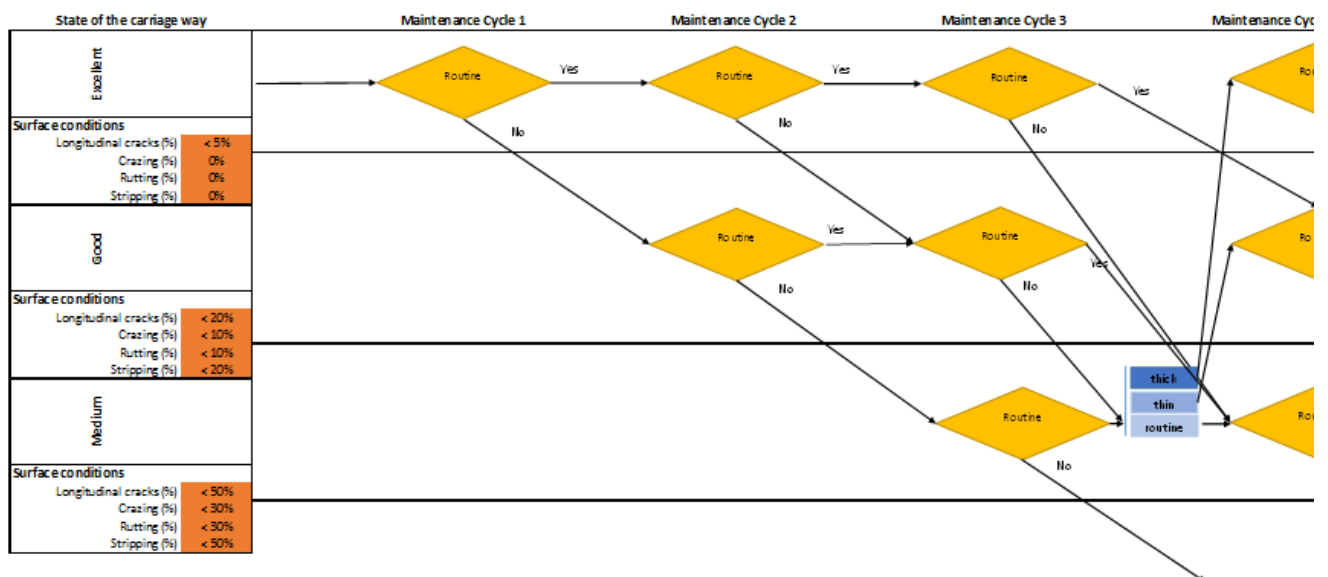

Fig. 7 Example of a possible maintenance scenario.

Fig. 8   Poor maintenance work.

Fig. 9   Use of thin surfacing technology.

6. White Paper for Policy Makers

The involvement of policy makers in this process is crucial. In parallel with the work of the GEPUR group, a white paper entitled "Entretenir et préserver le patrimoine d'infrastructures de transport: une exigence pour la France (Maintaining and preserving the transport infrastructure asset: a requirement for France)" was published by the IDRRIM in November 2014. This well-illustrated document of about twenty pages is for policy makers responsible for road networks within local authorities. It was published in the 25th World Road Congress in Seoul in November 2015, in Section 2 under the title "Le sous-entretien des infrastructures de transport: dette invisible sur l'avenir (Under-maintenance of transport infrastructure: an invisible debt for the future)" [5].

7. Conclusions and Perspectives

GEPUR is a working group deriving from an original partnership, initiated by IDRRIM, which brings together under the auspices of Cotita Est representatives of departmental councils and representatives of towns in the Greater East region of France, with the help of Cerema agents.

The aim is to produce a methodology for maintaining inter-urban and urban road networks, for managers, to help them optimize the maintenance of their network, taking into account the specifity of their data and to engage constructively with their elected representatives.

A white paper, aimed at elected representatives, was wrote to complete this work.

The technical guide for departmental networks was published in mid-2015; the one for urban networks will be published in mid-2017. Both guides should enable managers in the action zone to structure their road networks in three or four categories corresponding to a different level of service, with regard to programming multi-year maintenance for every category consistent with the local authority budget. Ultimately, the experience gained in Eastern France should be applied to other French regions.

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