# Maintenance of the road infrastructure in Republic of Macedonia

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## Abstract

Maintenance of roads represents a complicated engineering - economic task, which presents a complex of measures taken for providing normal exploitation, safety on the road transport and preserving the value of the road network and the equipment. After building the road and its release in exploitation, there are two major synergistic factors destroying the road, those are traffic overload and environmental impacts. The ways and methods of maintaining roads are often according to state policy depending on financial opportunities. Maintenance of roads is very specific from technical and economical aspect, which impacts the organization and technology.

There is a total of 13.940 km road network in Republic of Macedonia from which 911 km are national (from which 251 km highway and 660 km national roads) and 3.771 km regional roads, that sums up to 4.682 km, while the other part of 9.258 km are local roads. We can conclude that road network compared with the other infrastructural traffic systems (ex. railway, water and air traffic), represents the most developed traffic system.

*Keywords: roads network, road maintenance, routine maintenance, winter maintenance, investment maintenance*

# 1 Introduction

Roads are construction works that are intended to enable the transfer of people and goods from point A to point B. But they also have greater social significance, so we can presume that the road infrastructure is the best indicator of the degree of development of a society. It is an indicator of power, but also of inferiority (impotence). Roads connect and unite. They connect places, cities, states, continents, civilizations, cultures, ideas, nationalities, families, friends and people.

Most movements, travel, transportation is carried along the roads. In Republic of Macedonia the roads and travel corridors passing through its territory have long standing tradition, dating back to ancient times. Macedonia has always been a crossroad of the Balkan, where major roads crossed. Existing road Corridors 8 (east - west) and 10 (north - south) as the shortest and fastest roads that connected the region with Europe and Asia, lead roots from the ancient roads "Via Militaris" (north - south) and "Via Egnatia"(east - west). [1]

Maintaining roads is a complex engineering - economic task which presents a complex of measures taken in order to enable normal operation, safety of road transport and preservation of the value of road network and equipment. After construction of the road and its release into exploitation, two main factors degradingly act in synergy, those are traffic load and natural influences. The ways and methods of maintenance of roads mostly are in the function of the adopted policy in the field of maintenance, which is always a reflection of the financial opportunities. Maintenance of roads has its own specifics on technical and economic aspect, which affects the organization and technology matters.

The road network in Macedonia is quite developed and has all ranks of roads with total length of 13.940 km (Tab. 1) [2]. These roads do not include urban roads and forest roads. From the above it can be concluded that the road network in comparison with other transport infrastructure systems (e.g. rail, air and waterway traffic), represents the most developed traffic system.

**Table 1.** Review of the lengths of the road network in the Republic of Macedonia

| Type of roads | Lenght [km] |
|---|---|
| Highways | 251 |
| National | 660 |
| Regional | 3.771 |
| Local | 9.258 |
| Total: | 13.940 |

According to the adopted Spatial Plan of RM for the next 25 years, 1.050 km of regional, 80 km of motorways and 240 km highway, from which 40 km of the corridor 10 (north - south) and 200 km of the corridor 8 (east - west) should be completed. Through the territory of the Republic of Macedonia pass and cross two very important international road corridors - Corridor VII (east - west) with a total length of 304 km in Macedonia and Corridor X (north - south) with a total length in Macedonia from 174 km. (Fig. 1).


**Figure 1.** Republic of Macedonia in European road corridors

International or "E" roads which pass through Macedonia [3], with a total length of 587 km are the following: E – 65 (length in Macedonia of 279 km); E – 75 (length in Macedonia of 174 km); E – 852 (length in Macedonia of 60 км) and E – 871 (length in Macedonia of 74 км).

## 2 Organizational structure of maintenance

Modern understanding of the term management, or managing road networks within the Managing system for roads, is not only about their planning and construction, but also their maintenance, rehabilitation and reconstruction of pavements already constructed on the roads (financial resources from second generation), from the first day after commissioning of the road. [4]

Macedonia until several years ago was into possession of the management and maintenance of roads from the last system of social and political order (socialism). In the previous period since the independence of Republic of Macedonia, a change in the system for managing roads suitable for the modern times and social and political system was suggested, from state to market management and maintenance of roads.

A partial transformation of the road sector was performed, expressed by transformation in the management structure - Agency for State Roads - **ASR** (former Fund for national and regional roads), and in the next period should be performed a transformation of the contractor who maintain the roads, the Public Enterprise for maintenance of national and regional roads "Makedonijapat". The model for the transformation of the PE "Makedonijapat" is not yet defined and is under construction. The current organizational structure of the maintenance of roads is shown in Fig. 2. PE "Makedonijapat" cares for the maintenance of highways, national and regional roads. The total length of roads maintained is 4.482 km, from which 251 km highway, 660 km of national and 3.771 km of regional roads. The performance of this task is realized with about 1.500 employees, 4 asphalt bases (one of which with a capacity of 60 [t] and 3 more asphalt bases with a capacity of 40 [t]), 110 trucks with different size and other construction machinery.

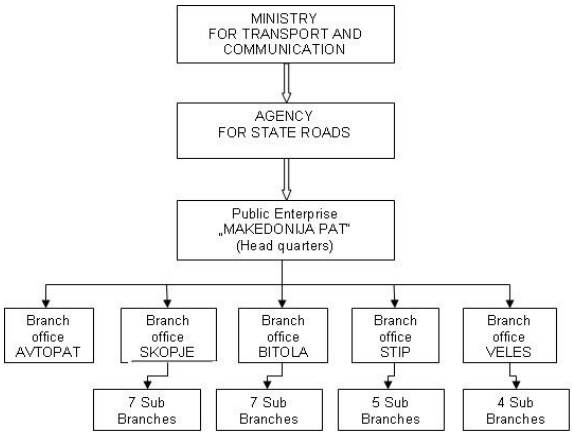


**Figure 2.** Organizational structure of the management of roads in Macedonia

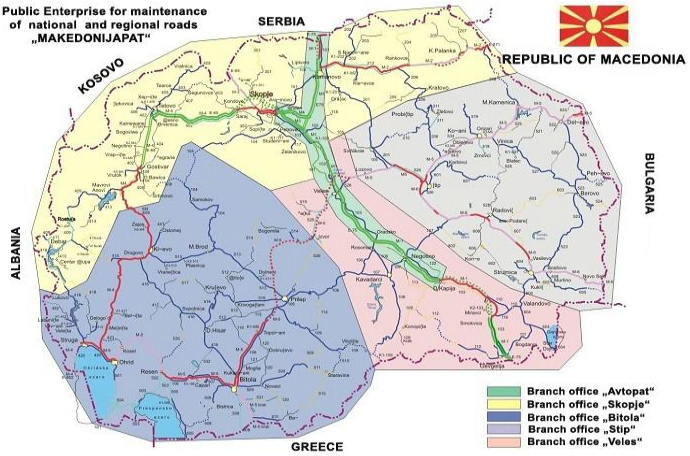


**Figure 3.** Organizational division of the PE "Makedonijapat"

## 3 Maintenance of roads

Road maintenance, means striving to maintain the road as long as possible in the condition, as it is during commissioning in exploitation without specific qualitative changes, which will ensure security and continuity of traffic flows as well as achievement of the defined levels of service on the road to users. Newly built or reconstructed roads should be properly exploited and maintained. Over time, under the influence of several factors (traffic load, natural influences, etc.) comes to degrading changes in the road network, which further requires taking appropriate measures and restoring the road to its original condition.

The complexity of maintenance can be seen in the process of working, usually without interruption of traffic (so-called "work under traffic"), in all seasons uninterrupted. Maintenance of roads has its own specifics as in technical and

economic aspect, which affects the organization and technology matters. The ways and methods of maintenance of roads mostly are in function of the adopted policy in the field of maintenance, which is always a reflection of the financial opportunities. In the Republic of Macedonia recently the total investment (construction and maintenance) in the road network are moving just over 100 million euros annually from which are separated around 16 million euros annually for maintenance in the last five years or the budget for maintenance is about 16% [5]. The existing condition of roads in the Republic of Macedonia, according to the National Transport Strategy is shown in Table 2 [6]. The condition of roads has changed especially in the regional and local roads with the realization of the project of the Government of Republic Macedonia "Program to support the project for regional and local roads in RM for 2008-2012" for improving and modernization of the regional and local road network. This project was financed with loans from the World Bank (70 million euros) and the European Bank for Reconstruction and Development (50 million euros), includes the reconstruction and rehabilitation are 455 km of regional and 641 km of local roads [7].

**Table 2.** Condition of roads in Republic of Macedonia

| Type of roads | Good | Average | Bad |
|---|---|---|---|
| **Highways (M 2×2)** | 60% | 30% | 10% |
| **National (M 1×2)** | 60% | 30% | 10% |
| **Regional (R1)** | 45% | 27% | 28% |
| **Regional (R2)** | 20% | 30% | 50% |

The structural separation of the road maintenance is the following: Routine, Winter and Investment maintenance and Other things related to road maintenance.

### 3.1 Routine maintenance

In practice, regular maintenance is maintenance consisting of several different positions that systematically and daily are undertaken on the road infrastructure (in the annual period: spring-summer-autumn) and don't make its qualitative improvements. By definition, regular maintenance represents striving a certain road or object to be held in the basic state as much as possible, with technical value that enables optimum exploitation, without achieving specific qualitative improvements. The basic goals of regular maintenance are defined by the commitment for providing continuous, rapid and safe transport. The realization of these goals requires continuous monitoring of the condition of roads and rapid response and entry into action that will enable continuous exploitation of roads. While performing the tasks of the domain of regular maintenance, in addition to labor force proper machinery is used. Some characteristic positions of things or global groups from this type of maintenance are: Work on the road signs and equipment, Work on travel and associated structures (Fig. 4), Work on the road surface and Work on the earth corpse on the road.

### 3.2 Winter maintenance

The main goal of the winter maintenance is to provide uninterrupted and safe transport of all traffic participants. Unfavorable weather conditions that occur in winter expressed by low temperatures, the presence of snow and ice on the road surface, can significantly reduce the capacity flow and service levels of road, or in extreme cases to cause interruption in traffic. Quality implementation of the activities of the winter service (Fig. 5) depends on several factors including: geographic location, specific climate conditions, altitude, the economic power of the country, traffic volume and density of traffic, the traffic load on the road, the equipment with mechanization, method of management and management with the selected model of winter maintenance, collaboration with other subjects involved in traffic (Ministry of Internal Affairs - Traffic police, Auto Moto Association of Macedonia - **AMAM** and Hydro Meteorological Institute) and other. Organizational accomplishment of its task of winter maintenance, PE "Makedonijapat" was realized over 37 winter stations dispersed throughout the road network in the Republic of Macedonia, based on previously adopted "Operational program" [8], in accordance with ASR, two degrees preparedness, including: **First level of readiness** (a period of normal winter conditions, with average snowfall and average air temperature (about -2° Celsius)), and **Second level of readiness** (or longer period of intense snowfall, lasting low temperatures, interruption of traffic and others).
Organization characteristics of system for winter maintenance is based on operational, especially the financial opportunities and a division of roads into four priorities is made, the classification of roads themselves is based on the intensity and size of traffic Average Annual Daily Traffic (**AADT**), commercial significance and location of the road network.
Experience as the main factors that contribute to efficient and quality winter maintenance, impose the following three: Engaged skilled and professional workforce, mashinery (construction and special) and Materials (chemical and abrasive). For winter maintenance should in Macedonia as a means for melting snow and ice we are using salt (sodium chloride NaCl), fine crushed stone (with a certain grain) and mixtures in the appropriate ratio of salt and fine crushed stone [9]. For winter road maintenance, consumption of materials for winter service ranges between 12.000 - 15.000 [t] salt and 20.000 - 22.000 [$m^3$] fine crushed stone, and as specific machinery used and 7 special mashinery – snow casting. No less important part of the whole system of winter maintenance is also information system, Dispatch - Information Centre, which collects all data about the condition of roads and submit them to competent authorities (Department of PE "Makedonijapat", ASR, AMAM).

### 3.3 Investment maintenance

Things performed in investment maintenance are: rehabilitation or strengthening of road construction (Fig. 6), widening the road, partial correction of the alignment of the road, rehabilitation facilities, rehabilitation of landslides and protecting the road trunk, reconstruction of "black spot" and others. It is important to note that there is a difference between restoration and maintenance investment, because investment maintenance is performed to improve the condition of roads, resulting in raising the level of service roads, but does not change the geometry and the

elements of the road. The situation regarding the maintenance of the facilities of roads, such as omissions, bridges, viaducts, is relatively improved, thanks to foreign aid and donations from the U.S. Army and NATO, which has realized five projects to strengthen bridges.

### 3.4 Other matters related to maintenance

In this group of works relating to maintenance of roads belong: **Protection of roads** (which means taking necessary measures to prevent illegal actions in the trunk road, road and buffer zone and control the weight of vehicles,etc..); **Counting of vehicles** (during the year are automatically and manually counting the traffic on the roads, it performs data processing and issuing "Annual data of traffic counting of national and regional roads in Republic of Macedonia"); **Collection of road tax - toll** - (According The Law for public roads for driving on the highway sections of the road network in the Republic of Macedonia, tolls are paid, organized through the pay toll service) (Fig. 8); **Land-road cadastre** (keep a record of the condition of roads); **Dispatch - Information Centre** (collect all information on state road 24 hours/day and distributed to relevant institutions, media and public); **Design-section** (prepare project documentation for maintenance and protection of roads) and more.

**Figure 4.** Regular annual reviews of the bridges of the road network

**Figure 5.** Winter maintenance of mountain saddle Straza (1.150 m altitude) on the national road M-4 (E-75)

**Figure 6.** Maintenance of roads (Restoration of surface roads)

**Figure 7.** Automatic vehicle traffic counters “Sterela”


**Figure 8.** Locations of the toll stations on highways in Republic of Macedonia

## 4 Conclusion and recommendations

We can say that maintenance of the road network in the Republic of Macedonia can and must be raised to a qualitatively higher level, based on a strategy aimed at achieving the qualitative level of maintenance on roads that are practiced in the EU states in due time. With the accession of the Republic of Macedonia towards full EU membership, this task gets more importance. More over, it is important to emphasize that without adequate financial support and professional design of the annual program for maintenance of roads will be difficult to achieve the desired effect of maintaining the road infrastructure.

The discrepancy between actual needs and possibilities, between the necessary funds for maintenance and anticipated in the budget for maintenance of roads, contribute to slow modernization of road network. Late intervention in the renewal and strengthening of pavement structures with geometrical progression raise funds for that purpose, and reduce and traffic safety [10]. The development of scientific-technical progress in road maintenance requires first grade way of funding and requires synchronized application of technical innovations on the one hand and modern organization in managing roads on the other side. Concrete steps to be taken, are the following:

- Transformation of the company for maintenance of roads;
- Modernization of winter maintenance (purchase of new and more contemporary special machinery for winter maintenance, leaving the maintenance of roads with sanding with fine crushed stone and transition to a liquid calcium chloride ($CaCl_2$);
- Modernization of the existing system of toll collection;
- Increase the level of sustainable traffic safety and immediate resolution of the “black spot” on the road;
- Supplying sophisticated equipment and devices for monitoring the condition of roads;
- Creation of a database by following the basic indicators of condition of roads and introduction of appropriate software technology;
- Harmonisation of our legislation with EU directives and EU legislation.

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