



ESTONIAN ROAD NETWORK AND ROAD MANAGEMENT

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Abstract. Estonian public road network is one of the densest in the Baltic and Nordic countries with the 52,8 % of paved state roads. Also it is specific in the sense of the organisation of road management the maintenance of which is implemented partly by private contractors (in 10 counties from 15) and by the state (in 5 counties). The competition between different contractors and the state will help control the growth of maintenance costs. Financing the road management has been improved during the past few years considerably: from 47,9 m euros in 1999 up to 125,7 m euros in 2004. It has caused the improvement of the condition of main roads of the state road network. At the same time the financing conditions set up by some institutions have led to the deterioration of basic and secondary roads. Despite the annual growth of the budget of the Estonian Road Administration, not enough finances are allocated for the repair and construction of state roads. For the construction, repair and maintenance of state roads 79,5 m euros were used in 2004 but the need was about 138 m according to the Estonian Pavement Management System. Therefore we cannot expect a rapid improvement of the conditions of Estonian state road network and still a lot of efforts is to be spent to keep the current condition of the state road network.

Keywords: road network, pavement types, road management, maintenance, financing, road condition, roughness, distresses, bearing capacity, rutting, planning.

1. Estonian road network

Estonian road network is divided into rural roads and urban roads and streets. Rural roads are divided into state roads (managed by the Estonian Road Administration) and other roads (including roads managed by the local governments and private roads) (Table 1). State roads include only 29 % of the whole Estonian road network but they are the

most essential from the point of public traffic and carry about 90 % of the traffic volume in rural areas.

Density of the Estonian state road network is 380 km per 1000 km² which is one of the densest in the Northern Europe and Baltic states (Fig 1). Density of the whole Estonian road network is 1313 km per 1000 km². There are 923 bridges with the total length of 2185 metres of the state roads.

Table 1. Entity of Estonian roads (Jan 1, 2005) [1]

| Road type | Length, km | Share of the whole road network, % |
|---|------------|------------------------------------|
| <i>State roads</i> | 16 459 | 29 |
| incl. Main roads | 1 601 | 2,8 |
| Basic roads | 2 380 | 4,2 |
| Secondary roads | 12 435 | 21,9 |
| Ramps | 43 | 0,1 |
| <i>Other (local, private etc) roads</i> | 37 188 | 65,4 |
| <i>Urban roads and streets</i> | 3 153 | 5,6 |
| Total | 56 800 | 100 |

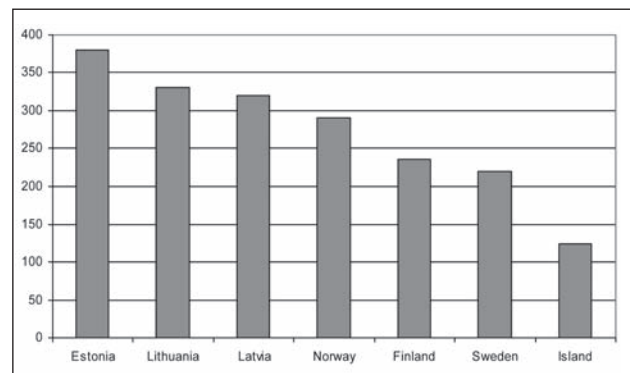


Fig 1. Density of state road network (km/1000 km²) in the Northern Europe and Baltic states

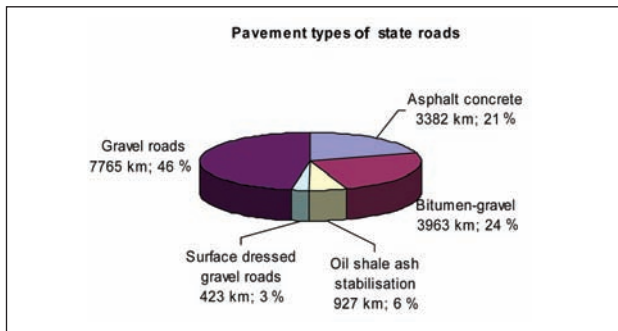


Fig 2. Pavement types of Estonian state roads [1]

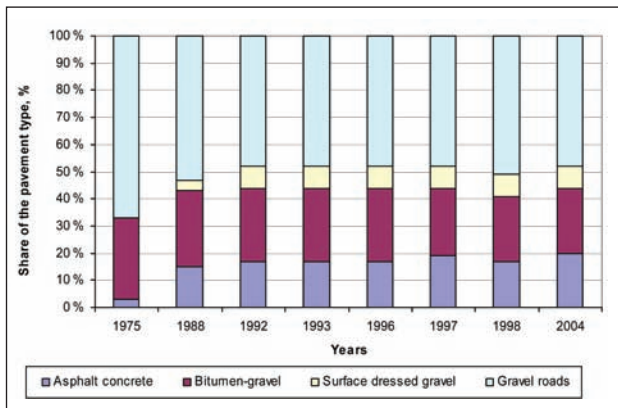


Fig 3. Change of the share of pavement types of state roads [1]

52,8 % of state roads (Fig 2) and 11,5 % of other roads and streets are paved. There are no significant changes taking place in the length of different pavement types during the past 15 years (Fig 3). To some extent the length of bitumen-gravel pavements has decreased and the length of asphalt concrete pavements increased. The increase of the length of gravel pavements is mainly caused by the transfer of local roads to the status of state roads.

2. Road management

The term “road management” includes the complex of activities meant for the construction, maintenance, preservation and development of the road network. State roads of Estonia are managed by the Road Administration which is the governmental agency operating under the Ministry of Economy and Communications of the Republic of Estonia.

The reorganisation of the Estonian road management system was started in 2000. The aim of it was to decrease the relative part of the state and accordingly to increase the part of the private sector in the area of road management:

- Separation of roles of customer and performer;
- Increase of the administrative capability of customer;
- Involvement of private funds and creation of competition in road sector;

- Decrease of administrative expenses of the state budget.

State will retain the functions of planning, ordering and supervision.

Preconditions for the privatisation of road management are:

- Adequately developed normative base;
- Existence of private contractors strong enough to carry out the road management activities.

Such a kind of normative base was created in Estonia by the year 2000 and it has been constantly supplemented. Also at that time there existed quite strong contractors, dealing with road construction and willing to enlarge their activities to the area of road maintenance, too.

In 10 counties (= road districts) from the 15 three bidding procedures were implemented in each in 2000–2004:

- To perform the road maintenance activities on the state roads formerly maintained by the district road office;
- To sell the machinery and equipment of the district road office maintaining those roads so far;
- To rent the buildings and real estate needed for road maintenance.

All concluded maintenance contracts are based on the condition requirements with the total sum. The contracting period is 5 years (for that reason the buildings and real estate needed for road maintenance was not sold but rented, to ensure that the winner of the next bidding after 5 years will have the infrastructure needed for the execution of maintenance activities). In the rest 5 counties from the 15, the maintenance of state roads is performed by the state operated Regional Road Offices (Fig 4).

As the result of reorganisation there were one Regional Road Administration and 5 Regional Road Offices left in 2005 of the 15 District Road Offices in 2002 accordingly managing state roads in 2 or 3 counties:

- Northern Regional Road Administration (established in 01 01 2005, Harju, Järva and Rapla counties);
- Tartu Regional Road Office (est 01 07 2002, Tartu and Jõgeva counties);

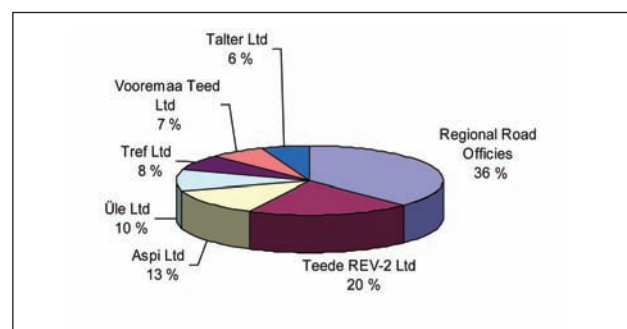


Fig 4. Maintenance performers on state roads [1]

Table 2. Work performed by contractors in 2000–2004 [2]

| | | Expenses (m euros) | | | | |
|--|---------|--------------------|------|------|------|------|
| Year | | 2000 | 2001 | 2002 | 2003 | 2004 |
| Construction, repair and maintenance total | | 37,0 | 34,5 | 62,8 | 70,4 | 79,5 |
| Performed by contractors | M euros | 22,0 | 22,4 | 53,0 | 62,2 | 67,6 |
| | % | 59,6 | 65 | 84,6 | 88,1 | 85 |

- Kagu Regional Road Office (est 01 11 2002, Võru, Põlva and Valga counties);
- Saarte Regional Road Office (est 01 12 2002, Saare and Hiiu counties);
- Pärnu Regional Road Office (est 01 01 2003, Pärnu, Lääne and Viljandi counties);
- Viru Regional Road Office (est 01 04 2003, Lääne-Viru and Ida-Viru counties).

About 85 % of all road construction, repair and maintenance works were performed by contractors for about 67,6 m euros in 2004 (Table 2).

3. Financing the road management

According to the Road Act [3], the sum equivalent to 75 % of the fuel excise is to be allocated for state roads management. Until 2003 this sum was formed from the money of state budget and loans. Since 2003 the intended sum for the state roads management includes, besides the state budget and loan money, also internal funds and aid from the European Union. As a result of this the amount of money directed from the fuel excise for road management is the smaller the tax, the bigger is the foreign aid. Real amount from the fuel excise used for the road management is about 31–45 % depending on the amount of aid from European Union in different years [1]. After funds of European Union became available for Estonia, our government decided to desist from the loans intended for road management.

Since Estonia joining the European Union has the possibility to apply support for the development of environmental and transport infrastructure from the European Cohesion Fund. About 90 m euros can be used for construction and repair of Estonian roads belonging to the Trans-European Road Network (TEN-T) in 2004–2006. In addition to the Cohesion Fund, Estonia can apply for co-financing the road construction and repair from the European Regional Development Fund. For regional projects improving living environment and developing state road network, 20 m euros are allocated in 2004–2006. Resources from the Cohesion Fund can be used only on Estonian main road but resources from the Regional Development Fund on basic and secondary roads, too.

Budget for state road management has grown by 2,6 times during past 5 years (Table 3). 34 m euros, allocated

Table 3. Finances allocated for management of state roads in 1999–2004 (m euros) [2]

| Year | Planned finances | | Used finances | | | |
|------|------------------|---------------|---------------|--------------------|-------------|---------------|
| | Total | Loans and aid | Total | From state budget | | Loans and aid |
| | | | | Operating expenses | Investments | |
| 1999 | 47,9 | – | 47,9 | 40,5 | 7,4 | – |
| 2000 | 50,8 | 1,5 | 50,8 | 38,3 | 11,0 | 1,5 |
| 2001 | 49,7 | 6,0 | 49,5 | 31,1 | 12,4 | 6,0 |
| 2002 | 79,2 | 33,6 | 71,3 | 29,7 | 15,8 | 25,8 |
| 2003 | 96,6 | 41,0 | 77,3 | 29,6 | 25,1 | 22,6 |
| 2004 | 125,7 | 36,8 | 91,6 | 34,3 | 40,8 | 16,5 |

for managing state roads, were not used by the Estonian Road Administration in 2004. Reasons for that are different, but some of them can be pointed out: 1) project approval in Brussels takes more time than originally planned; 2) administrative ability of the Estonian Road Administration is too low; 3) shortage of road designers is prolonging the design period; etc. To raise the administrative ability of the Road Administration the Department of European Programs and Regional Projects are formed to manage the projects with European co-financing.

4. Road condition

Systematic collection of condition data on state roads started in 1995. The following data are collected and stored in Road Data Bank for every 100 m section of the road [4]:

- Pavement roughness (IRI – International Roughness Index, mm/m);
- Pavement distresses (DS – Distress Sum, %);
- Bearing capacity of the road (E-modulus, MPa);
- Rut depth (mm).

4.1. Roughness

Roughness of the road pavement is evaluated by the International Roughness Index [5, 6] according to the following scale [7]:

- $IRI \leq 1,39$ mm/m – very good;
- $IRI = 1,40 \dots 2,69$ mm/m – good;
- $IRI = 2,70 \dots 4,19$ mm/m – satisfactory;
- $IRI = 4,20 \dots 5,59$ mm/m – poor;
- $IRI \geq 5,60$ mm/m – very poor.

Roughness of the state main roads was being improved during the last 9 years (Fig 5). The reason is that by the requirements of the financial institutions (banks, EU) most repair works executed in this period have taken place on main roads. As a result, the condition of basic roads has suffered – their roughness increased during several years.

A better roughness condition of main roads can be characterised by the distribution of roughness values of different road types (Fig 6). Accordingly, the roughness of

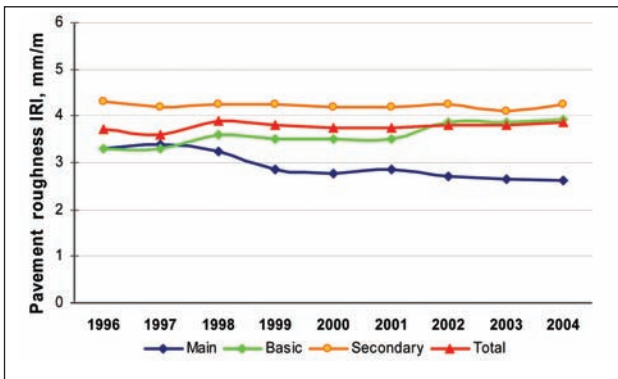


Fig 5. Change of the roughness of state road pavements in 1996–2004

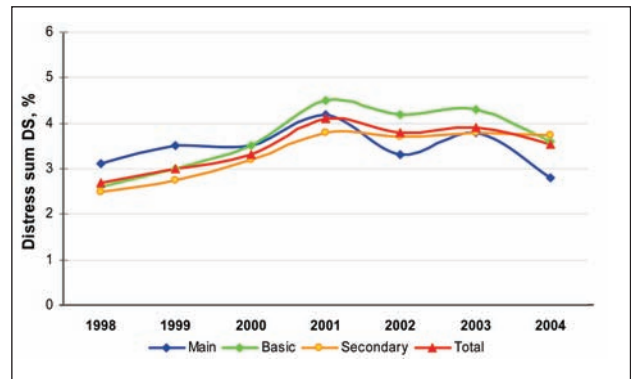


Fig 7. Distress sum (DS) variation of state roads in 1998–2004

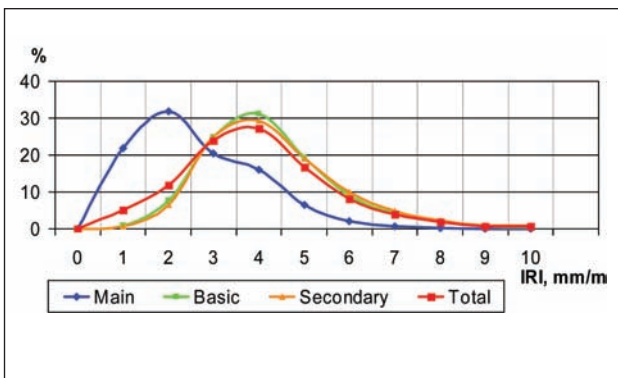


Fig 6. Distribution of roughness values of state roads on 01.01.2005

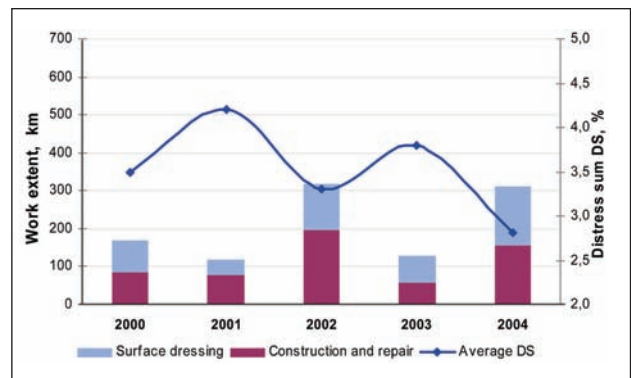


Fig 8. Dependence of the distress sum value on the surface dressing, repair and construction extent of the main roads

about 54 % of main roads and only of 9 % of basic and secondary roads is good.

4.2. Distresses

Pavement distresses are evaluated visually in spring when they are most visible. Distress inventory includes 10 distress types: transfer crack (pc), narrow and wide longitudinal cracks (m), narrow and wide joint cracks, alligator cracking (m²), pothole (pc), ravelling (m²) and broken edge (m). Based on the distress inventory, the distress sum (DS, %) is calculated for every 100 m section of the road which shows the percentage of damage pavement of the section.

Distress sum (DS) values for evaluation of pavement condition [8]:

- DS ≤ 1 % – very good;
- DS = 2 ... 5 % – good;
- DS = 6 ... 9 % – satisfactory;
- DS = 10 ... 19 % – poor;
- DS ≥ 20 % – very poor.

The distress sum value of Estonian state roads pavement is generally over satisfactory (Fig 7). At the same time the dependence of the distress sum values on the extent of repair work in corresponding road types can be noted (Fig 8).

4.3. Bearing capacity

Bearing capacity of the road is characterised by the E-modulus value on the pavement top (E, MPa) [8, 9]. Minimum acceptable E-modulus values of the pavement are determined by the Highway Design Norms [10], and they are depending on the road class and the pavement type (Table 4).

Distribution of E-modulus values (Fig 9) indicates that the problem of insufficient bearing capacity is not common for state roads (problems can occur only on short sections and mostly in spring thaw period).

Table 4. Minimum E-modulus values of the pavement (E, MPa) [10]

| Road class | Type of pavement | | |
|------------|------------------|-------|--------------|
| | Permanent | Light | Transitional |
| | E-modulus E, MPa | | |
| Freeway | 260 | – | – |
| I | 240 | 200 | – |
| II | 220 | 180 | – |
| III | 180 | 160 | – |
| IV | – | 140 | 70 |
| V | – | 120 | 70 |
| VI | – | 120 | 70 |

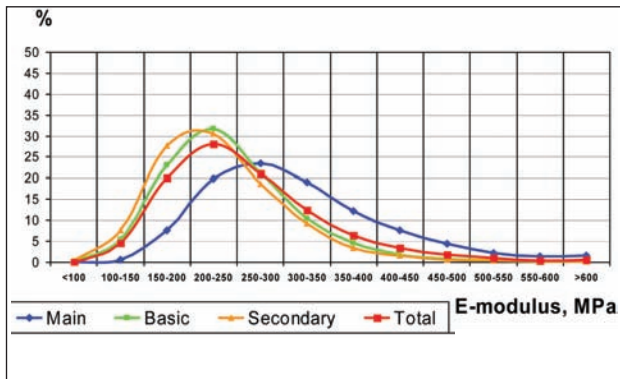


Fig 9. Distribution of E-modulus values (E, MPa) of state roads 01 01 2005

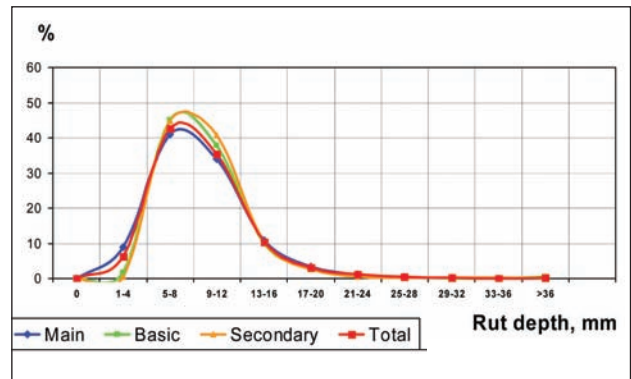


Fig 10. Distribution of rut depth values of state roads 01 01 2005

4.4. Rutting

Rutting of the pavement can be characterised with the average rut depth of the 100 m road section and evaluated as follows [7]:

- Rut depth < 5 mm – very good;
- Rut depth = 5 ... 10 mm – good;
- Rut depth = 10 ... 20 mm – satisfactory;
- Rut depth = 20 ... 30 mm – poor;
- Rut depth > 30 mm – very poor.

The rut depth over 20 mm [11] is influencing essentially the choice of the driving trajectory and speed. During a rainy period water is accumulating into the ruts and can cause the danger of aquaplaning. For that reason the rut depth over 20 mm is to be avoided.

Rut depth measurements on state road network are indicating that the amount of sections with rut depth value over 20 mm is not remarkable (Fig 10). At the same time 4 % of the state road pavements have ruts in the range of 17 ... 20 mm which means that preventive measures have to be taken to avoid further deterioration of those sections.

4.5. Repair planning

Road condition characteristics (roughness, distresses, bearing capacity, rut depth) described above with the traffic intensity represent the basis for determining the road sections to be repaired. For determining such sections, the Pavement Management System (PMS) is used with the objective to preserve and improve the condition of the existing road network assuring an optimal condition level and traffic safety.

For the PMS analysis two different types of software are used in Estonia:

- EPMS (Estonian Pavement Management System) [4] – enables to compare and to prioritise road sections to be repaired based on the road condition and first year benefit (used since 1999);
- HDM-4 (Highway Development and Management Model) [12] – used since 2000 for economical calculations both at network and project level. Requirements of the financial organisations (banks,

EU) to use the money only for main roads in the beginning of 2000 have led to an increase of length of basic and secondary road sections to be repaired (Fig 11) and as a result to the increase of cost of those repair works (Fig 12).

Despite the decrease of the length of road sections to be repaired during the last three years, the cost of their repair has increased. Reason for that is the increase of work per 1 km road done during the repair – earlier attention was paid only to the pavement repair, currently also to the embankment repair, ditching and road safety improvement are to be taken into account.

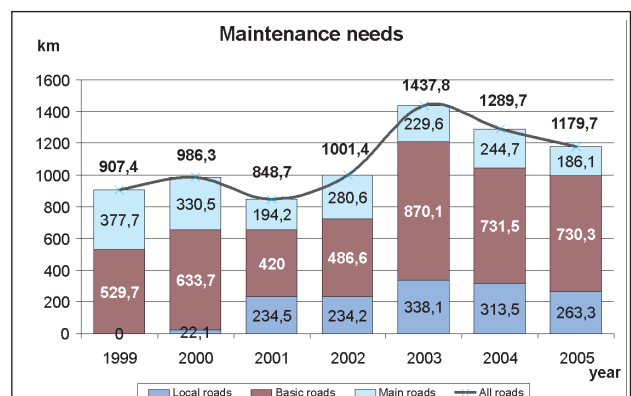


Fig 11. Length of road sections to be repaired in 1999–2005 determined by EPMS

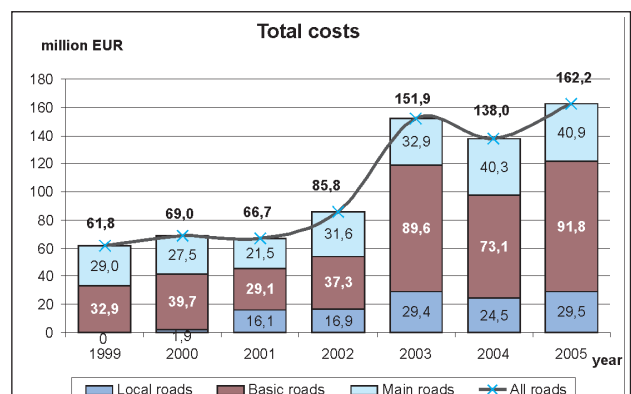


Fig 12. Cost of repair of road sections to be repaired in 1999–2005 determined by EPMS

Despite the annual growth of the Estonian Road Administration budget, not enough finances are allocated to the repair and construction of state roads. For these purpose only 79,5 m euros was used in 2004 (Table 2), but the real need was about 138 m euros (Fig 12). The difference between the allocation and need was about 1,7 times and therefore we cannot expect a rapid improvement of the state road network condition.

5. Conclusions

1. The Estonian state road network is one of the densest in the Baltic and Nordic countries with 380 km/1000km².

2. The reorganisation of the Estonian road management system was started in 2000 and as a result there were one Regional Road Administration and 5 Regional Road Offices left in 2005 of the 15 District Road Offices in 2002. In 10 counties from 15 the road maintenance has been performed by contractors. The competition between the different contractors and the state will help control the growth of maintenance costs.

3. About 85 % of all road construction, repair and maintenance work in Estonia were performed by contractors.

4. According to the Road Act, the sum equivalent to the 75 % of the fuel excise is to be allocated for state roads management. A real amount of the fuel excise used for road management is about 31–45 % depending on the amount of aid from the European Union in different years.

5. The budget for state road management has grown by 2,6 times during last 5 years. Despite the annual budget growth, not enough finances are allocated to the repair and construction of state roads. The difference between the allocation and the need for funds was about 1,7 times. Therefore we cannot expect a rapid improvement of the condition of state road network.

6. Roughness of the state main roads has been improved during last 9 years. At the same time the condition of basic roads has suffered – their roughness has increased during several years.

7. Distress sum value of Estonian state roads pavement is generally over satisfactory. At the same time it can be noted the dependence of the distress sum values on the extent of repair work of corresponding road types.

8. The problem of insufficient bearing capacity is not common for state roads (problems can occur only on short sections and mostly in spring thaw period).

9. Rut depth measurements of state road network indicate that the amount of sections with rut depth value over the critical 20 mm is not remarkable.

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Submitted 14 Dec 2005; accepted 13 Feb 2006