CETRA 2010 17–18 May 2010, Opatija, Croatia
First International Conference on Road and Rail Infrastructure

ASSET MANAGEMENT OF NATIONAL ROAD NETWORK IN CROATIA

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Abstract

The network of national roads in Croatia comprises of 6800 kilometres of mainly two-lane roads that constitute an important segment of the Croatian road system. The paper gives some main inventory data and describes the present condition of the national road network in Croatia. The emphasis is on pavements as the most valuable road asset. Expenditures in maintenance of national roads over the past four-year period (2005-2008) are analyzed. Financial and physical indicators are given and road condition development trends for the period are observed. The findings presented give an indication of the level of expenditure that will be needed during the next four-year period.
The authors have outlined the present approach to road management (pavement condition analysis method), and have described future improvements that should be introduced from the 2010 (the use of network optimization model).

1 Introduction

The aging of the existing network of national roads increases the need for rehabilitation and maintenance operations, but also for upgrading to accommodate ever growing traffic volumes that have exceeded design values. The growing backlog will have negative consequences for the economy. All countries, Croatia is no exception, have restricted and usually insufficient resources available for road maintenance. Therefore, the need for the most efficient use of restricted maintenance funds requires that a modern road asset management system is put to use.
Croatia uses a project level approach or pavement condition analysis method. This pavement management method is the simplest: it aggregates pavement condition information on the project level and then selects the most appropriate MR&R strategy. Future pavement condition is not considered. A set-up of a modern road asset management system that employs network optimization models has been included in the plans for the year 2010.

2 Inventory data on national roads

The size of national road network is 6809km. Almost the entire network consists of single carriageway roads - 98.5% of national roads fall in this category (usually two lanes, with a third lane as an exception on climbing sections or in populated areas). Only 100km of national roads (1.5%) are dual-carriageway. Almost all national roads are paved. In the year 2008, only 20km of national roads were surfaced with gravel. Carriageway widths in national roads vary in the range of less than 5.9 to over 7.1m. Carriageways on 14% of national roads are less than 5.9m wide, which is unacceptable even for national roads with very low traffic volumes. In further 40% of national roads, carriageway is wider than 5.9 m, but less than 6.4m wide, which is conditionally acceptable only for roads with very low traffic volumes.

Average annual daily traffic (AADT) on the national road network was 3694 vehicles/day. On 28% of national roads traffic volumes were below 1500 vehicles/day. Traffic volumes above 5000 vehicles/day were recorded on 22% of national roads, including only 4% of roads with AADT of 10.000 vehicles/day. (Fig. 1). Freight vehicles participated in 11% of AADT.

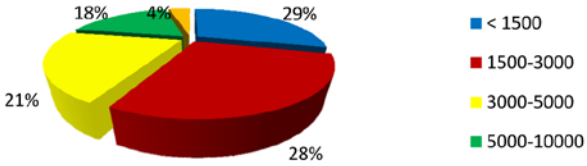

Figure 1 Percentages of AADT ranges on the national road network (2008)

3 Pavement condition of national roads

The condition of national roads, or road pavements, is assessed on the basis of the following data: longitudinal evenness, rut depths, surface defects (cracking and repairs) and pavement surface texture depth. Average values for 100-m or 200-m network segments are entered in the data base. Data are collected every year by measuring equipment (evenness, rutting and texture) and every two years by visual inspection (cracking and repairs of surface defects). Here below all collected data are analyzed and compared to specified limit values per each parameter that served to classify the pavement condition in three or five categories.

3.1 Longitudinal evenness

The assessment of condition of national roads with respect to longitudinal evenness of the surface has been made using the following criteria: very good condition – IRI below 1.5 m/km, good condition – IRI 1.5-2.5 m/km, fair condition – IRI 2.5-3.5 m/km, poor condition - IRI 3.5-5.0 m/km and very poor condition – IRI above 5.0 m/km. In terms of longitudinal evenness, 14% of national roads are in very good condition, 27% of roads are in good condition, while 23% of the network is in fair condition. Poor condition is present on 20% of roads, while 16% of national roads are in very poor condition (Fig. 2).

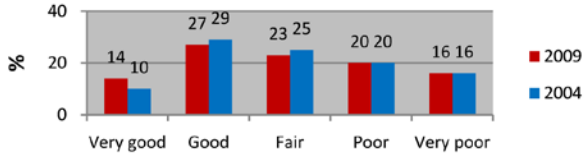

Figure 2 Longitudinal evenness on national roads in 2009 compared to status in 2004

Average longitudinal evenness of national roads today is 3.3 m/km IRI as compared to an average evenness of 3.4 m/km in the year 2004. Therefore, the average evenness on the level of network today has improved to some extent if compared to the condition measured in 2004. This shows that the levels of spending in maintenance of national roads in the observed period have not resulted in considerably improved condition in terms of longitudinal evenness, but neither has the condition worsened.
It can be noticed that the percentage of national road network with very good evenness has grown by 4% compared to the condition measured in the year 2004. However, at the same time, the percentage of national roads with good evenness has fallen by 2% while the percent of roads with fair condition have also fallen by 2%. The percentage of national roads with

poor and very poor evenness has remained unchanged. This means that in the past period the condition of national roads has not been improved. The percentage of roads in poor and very poor condition is still very high, 36%, and it has not been reduced in the past four years.

3.2 Rut depth

The assessment of pavement condition with respect to rut depth parameter (critical for safety) has been made using the following criteria: good condition – rut depth below 8mm, fair condition – rut depth from 8mm to 15mm, poor condition – rut depth more than 15mm. The condition of national roads in terms of rut depths is much better than the evenness condition. Most of the national network is in good condition (80%). Poor condition was measured on only 3% of roads (Fig. 3). The average rut depth is 5.2mm.

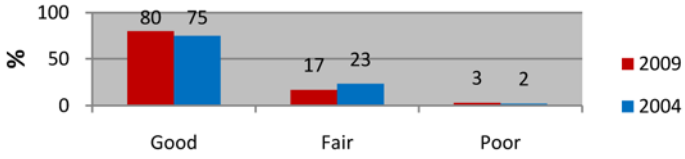

Figure 3 Rut depths on national roads in 2009 compared to status in 2004

The percentage of national roads that are in poor condition with respect to rut depth parameter has increased to 3% in early 2009 compared to 2% that was estimated in the year 2004. The percentage of national roads with fair rut depths has decreased from 23% to 17%. The proportion of national roads with good pavement condition in terms of rut depth has increased from 75% in 2004 to 80% in early 2009. Therefore, the percentage of national road network in good condition has increased by 5%, in terms of rut depths (rutting smaller than 8mm), and the percentage of roads in poor condition has also increased but only by 1% (rutting larger than 15mm).

3.3 Pavement surface defects

Cracking on pavement surface. The assessment of pavement condition with respect to crackings has been made using the following criteria: very good condition – absence of cracking, good condition – cracking present on less than 5% of road surface, fair condition – crackings present in 5-20% of road surface, poor condition – crackings present on 20-40% of road surface, and very poor condition – crackings present on more than 40% of road surface. Almost 60% of national roads have no crackings, while in 13% of national roads alligator cracking have affected less than 5% of pavement surface. On this roads, in terms of cracking, pavements are in good condition. On 14% of national roads the condition is fair. The condition on 6% of national roads is poor (cracking areas affect over 20% of road surface), while 8% of the national network is in very poor condition (Fig. 4).

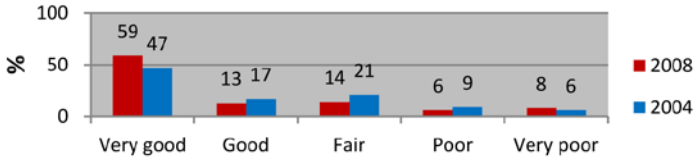

Figure 4 Condition of national roads in terms of pavement cracking in 2008 compared to 2004 status

The percentage of roads in good condition in terms of cracking has increased from 64% to 72%. This includes a considerable increase of roads without cracking (from 47% to 59%). The percentage of national roads in poor condition in terms of cracking of road surface (meaning that more than 20% of pavement has crackings) has been decreased insignificantly from 15% in 2004 to 14% in 2008. The percentage of roads that are still in fair condition has decreased from 21% to 14%. Assessing the developments on national roads in terms of cracking, it can be concluded that the condition in the observed period has improved, in particular within the very good condition class, or roads without defects such as crackings. However, the percentage of roads in poor condition has remained almost the same that is 14% of national roads fall within that assessment category.

Repaired pavement surface defects. Repairs are an indicator of the extent of defects repaired on a pavement segment. Large areas of such expeditious, but comparatively costly method to repair pavement surface indicate that such pavement rehabilitation measures should be selected and applied that would eliminate the need for continuous and extensive patching, in particular if various types of pavement defects continue to appear in spite of extensive repairs that had been carried out. Repaired surface defects are not present on almost two thirds of national roads, while on 6% of the network less than 2% of pavement area has been repaired. Significant percentages of pavement repairs (on over 20% of pavement surface) have been recorded on 10% of the national road network, while some 5% of national roads have had repairs of pavement surface defects ranging from 10% to 20% of the pavement surface.

3.4 Pavement surface macro-texture depth

The assessment of condition of national roads with respect to pavement surface macro-texture depth has been made using the following criteria: good condition – macro-texture depth over 0.7mm, fair condition – macro-texture depth from 0.5 to 0.7mm, poor condition – macro-texture depth less than 0.5mm. Good condition of pavement surface in terms of macro-texture has been observed in 31% of national roads, while in 23% of national roads the condition is fair. Poor condition was recorded on 46% of national roads (Fig. 5).

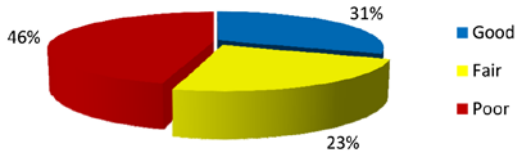

Figure 5 Pavement surface macro-texture depth on national roads

3.5 General pavement condition on national roads

General pavement condition on the network of national roads has been presented in three categories: good, fair and poor (Fig. 6). Macro-texture has not been included in the assessment of pavement condition because the comparison could not be made with the condition of pavements in the beginning of the past four-year period when it had not been possible to measure that parameter. The pavement condition has been assessed as poor if a single parameter (evenness, rut depth, cracking) had a poor indicator. Good condition was identified in 34% of pavements. One fourth of national roads are in fair condition. Very high percentage of national roads has pavements in poor condition, as much as 41% on the observed network. In other words, there is a considerable backlog in maintenance of national roads. The section that follows will discuss the comparison with the condition that was assessed early in 2005, at the beginning of the past four-year period. Poor condition pavements are most frequent on

national roads with low traffic volumes (AADT < 1500 vehicles), these are present in 55% roads. With the increase of traffic, the percentage of national roads in poor condition decreases, on the roads with the highest volumes poor condition pavements are present in 33% of the total. Such a distribution of pavement condition shows that the backlog in maintenance of national roads in the past resulted with general unsatisfactory condition of pavements on national roads. On the other hand, it is evident that the resources available were spent reasonably - on the roads with higher traffic.

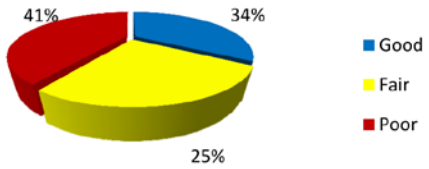

Figure 6 General condition of pavements in the national road network

It can be concluded that 28% of national roads were in good condition at the beginning of 2005, while in 2008 the percentage was 34% (Fig. 7). The percentage of national roads in fair condition has not changed and has remained at the level of 25%. In the four-year period the percentage of national roads in poor condition decreased from 47% to 41%, which is still very high.

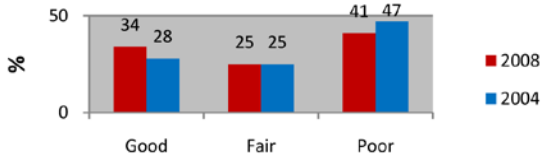

Figure 7 Changes in general condition of pavements on the national roads in the 2004-2008 period

Therefore, in the period observed there was a moderate improvement trend noticed in the condition of national roads: roads in poor condition were decreased by 6%. However, some 40% of national roads in poor condition at present are clearly showing the general poor condition of the network and a large backlog in maintenance. It has to be mentioned that during the observed period there was a change in the category of some roads within the national road network, so this perhaps influenced the developments mentioned above, but only marginally.

4 Maintenance and rehabilitation of national roads in the 2004–2008 period

The previous section described pavement condition developments in the past plan period from 2005 to 2008. Data on changes in condition of national roads shall be related to spending in maintenance and rehabilitation of the existing national roads and the works that had been carried out in the observed period. During the past plan period (2005 – 2008) the expenditures in the maintenance of national road network totalled 3,371.5 million HRK. Almost half of the total spending for maintenance operations, or 1,550.5 million HRK, was spent on routine maintenance. As a rule, routine maintenance does not have effect on the improvement of pavement conditions, although some activities do play a part in the prevention of fast significant deterioration of the condition.
Figure 11 exhibits expenditures in maintenance of roads over the four year period, together with annual structure of costs by maintenance categories. Two main conclusions my be drawn from the data presented:

- First, as evident from the figure, there was a positive trend of increase in spending on the maintenance of national roads in the observed period, from 661 mln HRK in 2005 to 1,147 million HRK in 2008. If such a trend continued in the next four-year period, a general improvement in the condition of national roads in future would be expected, but, given the circumstances (recession), this is unlikely.
- Second, it can be seen that in the first three observed years the budget for "capital" maintenance (periodic maintenance and betterment) of national roads was insufficient. In the first three years of the observed period, the budget allocations for capital maintenance were equal to or lower than the expenditures on routine maintenance. Such an unfavourable ratio certainly cannot lead to an improvement of the existing condition of national roads. A significant and a more logical trend of increased spending in capital maintenance rather than on routine maintenance could be seen only in 2008.

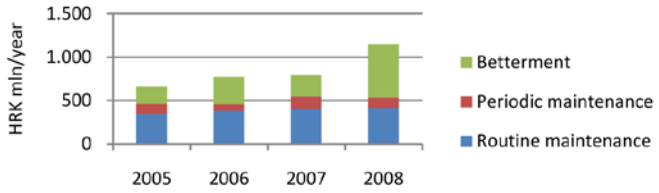

Figure 8 Spending on maintenance of national roads in the 2005-2008 period, shown with annual structure of costs by maintenance categories

The programs of periodic maintenance and betterment implemented in the 2005-2008 period resulted in rehabilitation of 650 kilometres of national roads or 9.5% of the national road network. On the average, in the observed four-year period, each year rehabilitation was carried out some 160km of national roads or 2.3% of the total network. In addition to works carried out within periodic maintenance and betterment program, some reconstruction of national roads was carried out within the construction projects managed by the Department of Construction Management at Hrvatske ceste. Some 40 kilometres of national roads were improved within the construction of bypasses of towns that were built either on the existing alignment of a national road or on new construction sections. Although such works should not be regarded within the maintenance category, ultimately they also contributed to overall improvement of the national road network condition.

Road maintenance in Croatia is still reactive instead of preventive, most maintenance treatments on the pavement include either pavement strengthening (46% of all measures) or upgrading of pavement or replacement of deteriorated pavement structure (38% of measures), which includes also measures taken to correct horizontal alignment of a road. Therefore, 84% of treatments include substantial structural improvement of pavement structure. On only 16% of sections, the measures included the improvement of functional properties of pavement, or rehabilitation of the wearing asphalt layer only. This is because rehabilitation of national roads included pavements in poor condition and pavement structure that was not appropriate for the traffic to which these roads were exposed.

5 Division of national road on homogenous section and condition assessment

In order to asses the need for maintenance/rehabilitation of pavement, the network of national roads was divided in sections with homogenous condition. Such sections are a basis for management of national roads and future rehabilitation planning. In the network there are about 1700 of homogenous sections with lengths that vary in the range from one to thirty

kilometres, the lengths that are realistic for planning of maintenance/rehabilitation projects. Single, combined and general performance indicators were calculated for each homogenous section, following the recommendations developed within the work of the European project COST 354 – Performance Indicators for Road Pavements. All indices were defined as dimensionless figures on a 0-5 scale.
Figure 9 shows the division into homogenous sections with various general index figures on a 0 to 5 scale, with lower figures representing good and higher figures poor condition, within the range from very poor to very good.

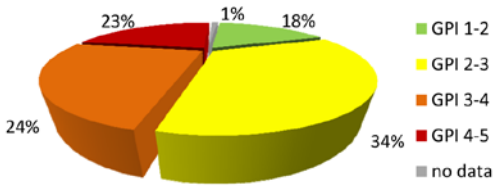

Figure 9 Division in homogenous sections with general performance index values within a 0 to 5 scale

General performance index of 0 to 1 (roads in top condition) has been obtained for several kilometres of national roads only (0% of national network). GPI values of 1 – 2 (roads in good condition) are present on 1217 kilometres of roads (18% of national network). GPI values of 3 – 4 (sections in poor condition) are present on 24% of network, or 1643 kilometres of roads. Sections in the worst condition are those that have GPI of 4 – 5 (very poor condition), and these are present on 1533km of national roads or 23% of the network. It has to be mentioned that these results cannot be compared with previously described results of analyses made for 100 (200)m segments.
Given that homogenous sections with GPI of 3 – 5 require various measures for improvement of pavements, and that 1000km of such sections needs carriageway widening, to eliminate poor condition on national roads would require works within the budget of 6.4 billion HRK.

6 Set-up of a modern asset management system for national roads

There are some questions that have to be answered first in an effort to maintain road assets with efficiency:

- What are the consequences of maintenance policies and what condition can be expected in five or ten years?
- What is the level of the annual budget for the existing national road assets to improve the condition of the network?
- What criteria should be used for the selection of works/sections?
- How to optimize the condition of the entire road assets?

In the case of road pavements, all analyses mentioned above are provided by a modern pavement management system. Since in Croatia such a system has not become operational yet, it is not possible to optimize approaches to road maintenance. Hrvatske ceste purchased dTIMS CT software (known as VIA PMS in Europe) for road assets management system and intend to start the set—up of the pavement management system through the use of that software. The services will be procured through international tender. The use of the system will enable road administration to optimize budget for maintenance/rehabilitation of national roads.

7 Conclusion

Systematic measuring/collection of pavement condition data on the national road network and the recording on the maintenance/rehabilitation works completed, enable a sound analysis of the condition of national roads and monitoring of condition developments through four-year periods. The last analysis of 2008 data has shown the improvement by some 6% that was achieved over the last four-year period (2005-2008).

Single, combined and general performance indices calculated following COST project 354 recommendations enabled a realistic assessment of the condition of national network, and the needs for maintenance/rehabilitation of road pavements. It was estimated that the elimination of national roads in poor condition requires a budget of about 6.4 billion HRK.

The condition of national roads described above requires the establishment and set-up of a modern asset management system. The road administration Hrvatske ceste intends to implement this task in the current year, through the use of already purchased software dTIMS CT (VIAPMS).