MAINTENANCE REQUIREMENTS FOR STATE ROADS IN AUSTRIA

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ABSTRACT

Budgets for the operation and maintenance of state roads in many countries and in Austria as well are steadily decreasing causing progressive deterioration of the pavements with serious consequences on the users and on the structural efficiency. Therefore the responsible road operators and administrations really need good arguments for discussions with the politicians to make sure that enough money is available for the road maintenance sector to keep the required condition, even in competition with other sectors like e.g. social matters.

With this general background the Austrian State Road Administrations decided to finance a common study on the effects of the actual, not satisfying maintenance budgets on the development of the road condition and to point out the need for additional money in order to keep at least the actual condition. This comprehensive study was conducted using available PMS-data of the respective networks. The results of the study are showing

- the increase of sections with a condition backlog until 2020 if only the actual budget is available
- the need of additional money to keep the actual (often not satisfying) condition until 2020 and to fulfil a target value of 20% backlog sections
- the reduction of the value of the pavement asset based on the structural index until 2020 if only the actual budget is available.

This study was finished in May 2011 and is being used by the road administrations in their efforts for sufficient financial means to fulfil their tasks in a sustainable way.

1 INTRODUCTION

Many road administrations worldwide are facing big problems to receive enough money for the maintenance of their road network because of common pressure for saving public financial means. The road administrations are in severe competition with other public sectors like social departments and public transport etc. Therefore it is important and necessary to develop clear figures which can be easily understood by the political decision level and can be presented in an impressive way showing the consequences which have to be envisaged if not enough money is available for the road infrastructure.

An important basis for this procedure is the definition how this actual condition of the road net can be described by a simple number and how this indicator will change by time in relation to the available maintenance budget. This simple indicator is called "maintenance backlog" and was investigated in depth in an ERA-NET Road project (ENR, 2009; Weninger-Vycudil et al., 2010) and is defined as "*the amount of unfulfilled demands at a given point of time in explicit reference to the predefined standards to be achieved. Maintenance backlog*

can be expressed in functional (non-monetary) or monetary terms and it refers to single components, sub-assets or to the whole road infrastructure asset of a given road network".

The Austrian State road network in the responsibility of the 9 Austrian states has a total length of about 33,700 km. It is an important part of the road infrastructure forming the level of roads below the federal motorways network of about 2,100 km. The average age of these roads is between 25 and 30 years. This relatively high age reflects of course in an increasing deterioration rate. Therefore the maintenance of this network receives a very high importance if the condition of the roads should not get worse. A precondition for securing a satisfying road condition is the provision of the necessary financial means for the constructive maintenance in the respective state budgets.

This serious situation led to the decision of the state road administrations to order a study (Litzka et.al., 2011) which should clearly point out the consequences of inadequate financial means for the constructive maintenance on the mid- and long-term development of the road condition and the asset value. The results should offer the necessary basis for the argumentation with the financial bodies for a satisfying maintenance budget.

2 METHODOLOGY OF THE STUDY

For internal reasons the study was dealing with the pavement only and the investigated maintenance measures were restricted to the constructive maintenance (rehabilitation, strengthening and renewal), which is planned following a given decision process. Thus operational maintenance and periodic routine maintenance were not taken into account.

Using the existing inventory data and the condition data for rutting, longitudinal evenness, skid resistance, surface distress and cracking a comprehensive PMS-analysis was conducted using the system VIAPMS, which is commonly used for the maintenance planning on the Austrian motorway network and on many of the state roads for many years. Within this procedure the single performance indicators or indexes respectively are formed to two combined performance indicators (comfort and safety index and structural index) and finally to a Total Condition Index (see Figure 1). Details of this procedure including the applied prediction models and of the PMS-systems in use in Austria can be found in Weninger-Vycudil et.al. (2004, 2009).

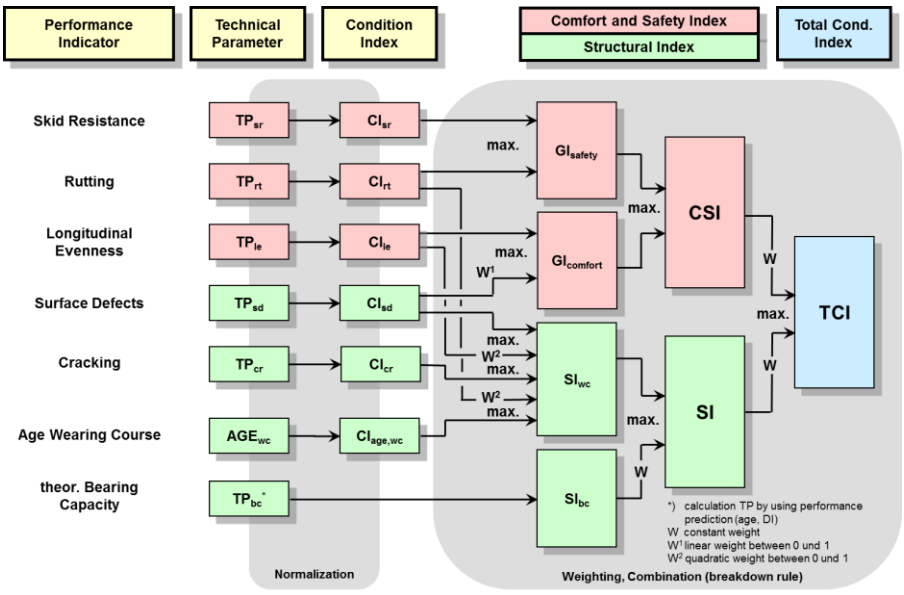

Figure 1: combined indexes and total condition index (Weninger-Vycudil, et.al., 2009)

For the study the existing basic data and the results from recent PMS-analyses could be used. These LCC-analyses had to be extended for various additional budget scenarios in order to get an information about the maintenance backlog after a given time period with respect to different available budgets. As a realistic time horizon 10 years were selected. So starting from the situation in 2010 the results for year 2020 were evaluated. The following characteristic numbers were calculated and used for the investigation:

- Maintenance backlog: as a functional (non-monetary) term according to Weninger-Vycudil et al. (2010) expressed as the sum of the lengths of road sections with a Total Condition Index (TCI) in condition class „4, poor“ and condition class „5, very poor“.
- Additionally the backlog of the Structural Index (SI) was investigated in the same way.
- Asset value: the calculation of the depreciation was based on the calculated structural condition of the given road section and not on the time.

For the calculation of the maintenance requirements for the representative state road networks the following steps were applied (Litzka et.al., 2011):

- Definition of additional budget scenarios (spectrum from 0 to max. 9,000 €/km and year)
- Calculation of optimized maintenance strategies for the given budget scenario
- Accumulation of the monetary and non-monetary characteristic values of the section-related maintenance proposals for the total network in form of condition distributions of the total condition index and the structural index
- Calculation of the backlog length for the total condition index in year 2020 for different budget scenarios
- Calculation of the backlog length for the structural condition index in year 2020 for different budget scenarios
- Calculation of the condition related asset value in year 2020 from the distribution of the structural index for different budget scenarios
- Displaying the results for each single state road network
- Comparison of the results for the different states and aggregation for the total Austrian state road network

3 RESULTS

3.1 General view on the total Austrian State road network

As indicated the study was focussing on a general evaluation for the total state road network. From the very beginning it was decided to exclude the state roads in Vienna (212 km) from the study as they are not comparable with the other state roads and thus not really representative. As not for all of the remaining 8 states the necessary information for the complete LCC-analyses with VIAPMS was available or the network under investigation was not equal to the total state network but only a selected part of it, for the overall evaluation for Austria the results from 5 representative states were used and extrapolated to the complete state road network. This general evaluation was conducted for total condition index only.

The results of this overall investigation formed the main part of the study and were reported already in Litzka et al. (2012). They are included in this paper in a summarized form.

Figure 2 shows the calculated average condition distribution of the total condition index TCI (left) and the maintenance backlog in year 2020 in relation to the available annual maintenance budget for the total state road network (right).

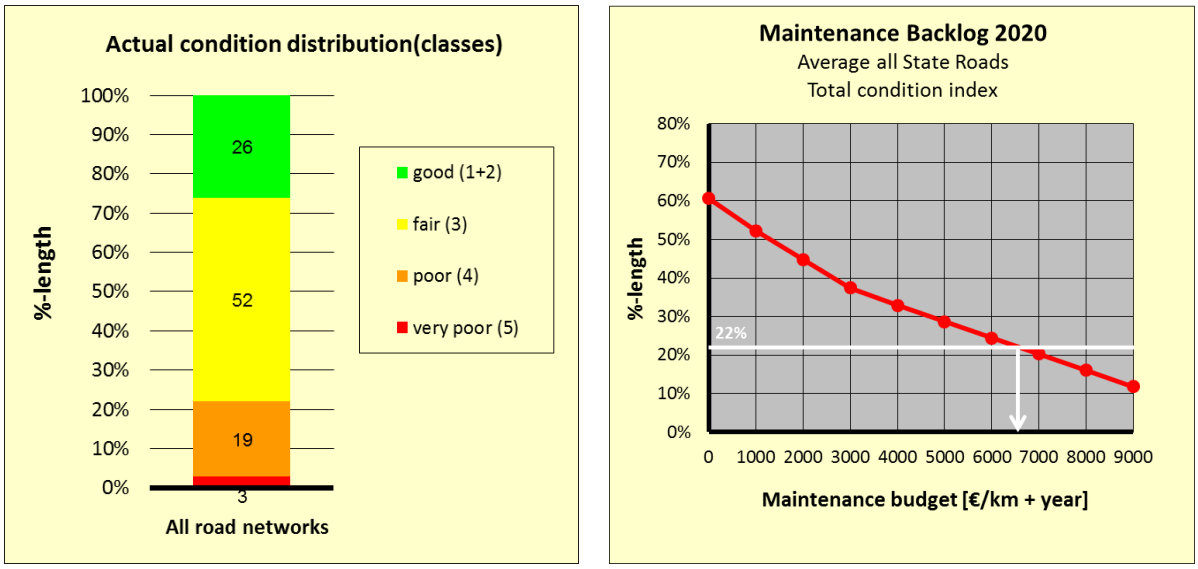

Figure 2: Total condition Index, average condition distribution and backlog 2020 versus available budget

The basic calculation shows that the average annual budget actually available is about 4,800 €/km and the average backlog length is 22%.

In Figure 3 the change of the backlog length from 2010 to 2020 is shown if the actual budget is kept equal (left) and on the other hand the necessary annual budget to secure a backlog rate of 20 % in year 2020 as target value (right).

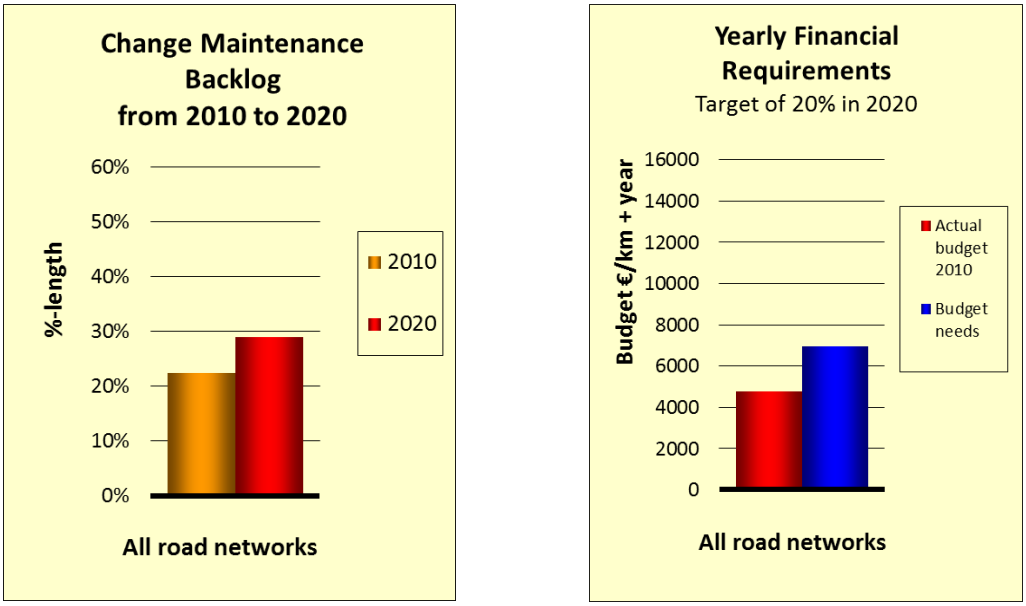

Figure 3: change of backlog length (TCI) with actual budget and necessary budget for target value 20 % in 2020

From the calculations and from the Figures 2 and 3 the following general statements can be drawn:

- To keep the actual generally not really satisfying backlog condition (22%) the same until year 2020 an amount of 6,600 €/km and year is necessary, this means an increase of the actual annual budget for 40 %
- With the actual available maintenance budget of 4,800 €/km and year an increase of the backlog length (sections in poor and very poor condition) of 7 percentage points has to be expected, this means additional 2,350 km of sections with backlog.
- To improve the actual road condition to an intended target value for the backlog length of 20 % in 2020 an increase of the actual annual budget for 46 % would be needed.

The calculation of the average asset value based on the structural condition shows a result of 165,000 €/km in year 2010 attributed to an average backlog for the structural index of 44 % of the network length. It could be shown, that the value for new construction of the complete pavement of the total state road network amounts to 11.4 billion €, while the actual asset value due to the structural condition is about 5.5 billion €, which will be almost be the same in year 2020. This also underlines the necessity for adequate means for the structural maintenance again.

3.2 Results on specific state level

As an example the results for one of the states for which complete data were available are shown. In this basic case the investigation was conducted more in detail, distinguishing between the different sub-networks of higher level state roads (B) and lower level state roads (L) on the one hand and between the Total Condition Index TCI and the Structural Index SI on the other hand.

The distinction between B- and L-roads has a historic background. Before 2002 the B-roads were federal roads operated by the states but financed by the Austrian federal road administration. In 2002 these roads were handed over to the full responsibility of the states together with an agreed financial transfer. Thus in most of the states the budgets for B- and L-roads are still kept separately. On the other hand, by looking not only on the global Total Condition Index but also on the Structural Index alone the necessity for long-term investment into the pavement structure can be pointed out.

This example road net consists of 302 km B-roads and 505 km L-roads, thus in total 807 km. The actual average annual budget for the structural maintenance of the pavement for this total network was fixed by the state road administration with an amount of 4,300 €/km (in total approx. 3.5 Mio. €/year).

Differentiated for the two road categories the evaluation was made according to a given actual annual maintenance budget for the B-roads of approx. 6,600 €/km and year (in total 2 Mio. €/year) and for the L-roads of approx. 3,000 €/km and year (in total 1.5 Mio. €/year).

3.2.1 Results based on the Total Condition Index

Figure 4 shows the condition distribution for the Total Condition Index for the two different sub-networks. It can be seen that the condition of the B-net is worse than that of the L-net.

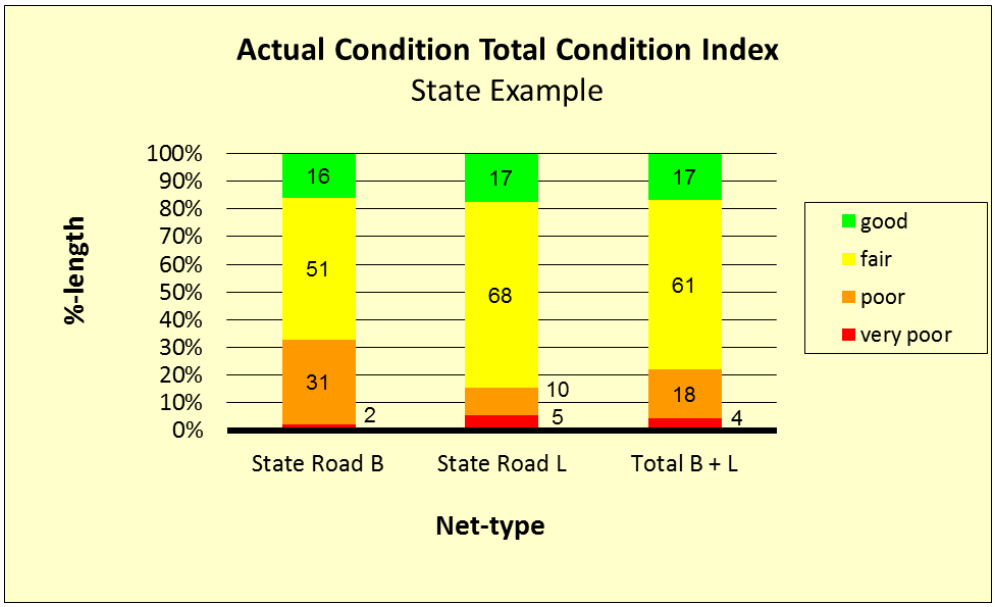

Figure 4: Condition distribution TCI for B- and L-network for one example state

The results for the evaluation of the maintenance backlog (backlog length) for the total road network in relation to the available budget are shown in Figure 5.

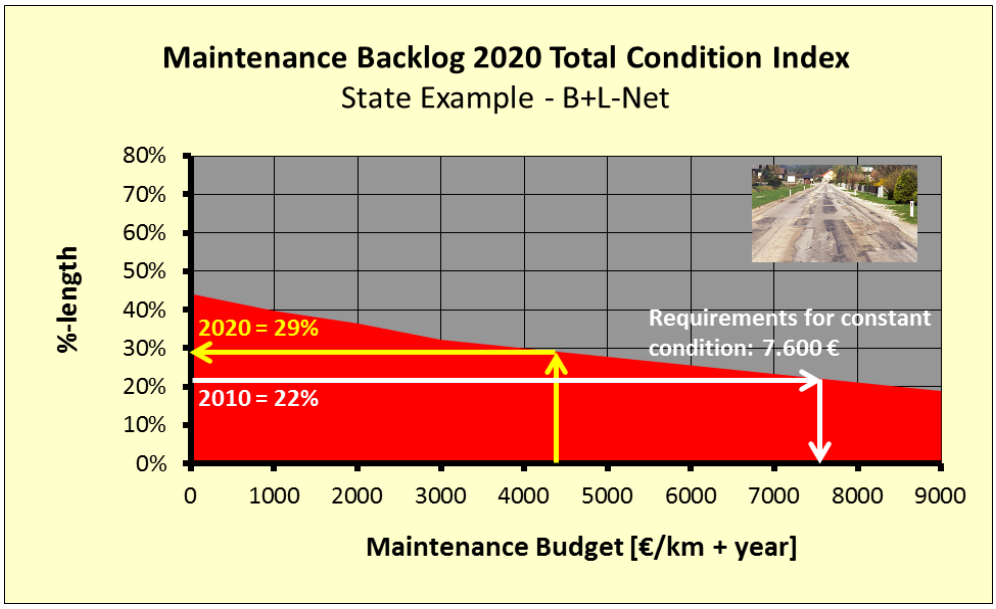

Figure 5: Backlog TCI in relation to available budget, total road network for example state

One can see that

- Keeping the actual annual average maintenance budget of 4,300 €/km and year results in an increase of the backlog from 22% in 2010 to 29% in 2020
- To keep the actual condition (22% backlog) until year 2020 approx. 7,600 €/km and year would be necessary (additional requirement 77%)
- To secure a backlog of 20% in 2020 approx. 8,500 €/km and year would be necessary

More differentiated information can be received by distinguishing between the two different sub-networks. Figure 6 shows the results for the B-net, Figure 7 is related to the L-net.

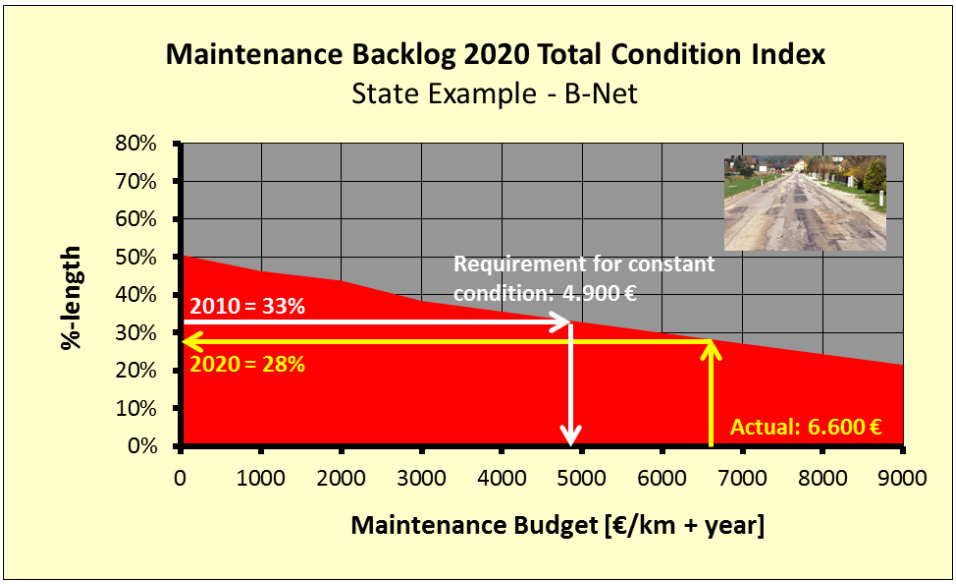

Figure 6: Backlog TCI in relation to available budget, B-net of example state

From Figure 6 one can see that

- Keeping the actual annual average maintenance budget for this subnet of 6,600 €/km and year results in a decrease of the backlog from 33% in 2010 to 28% in 2020
- To keep the actual condition (33% backlog) until year 2020 approx. 4,900 €/km and year would be sufficient (reduced requirement 26%)
- To secure a backlog of 20% in 2020 approx. 8,000 €/km and year would be necessary

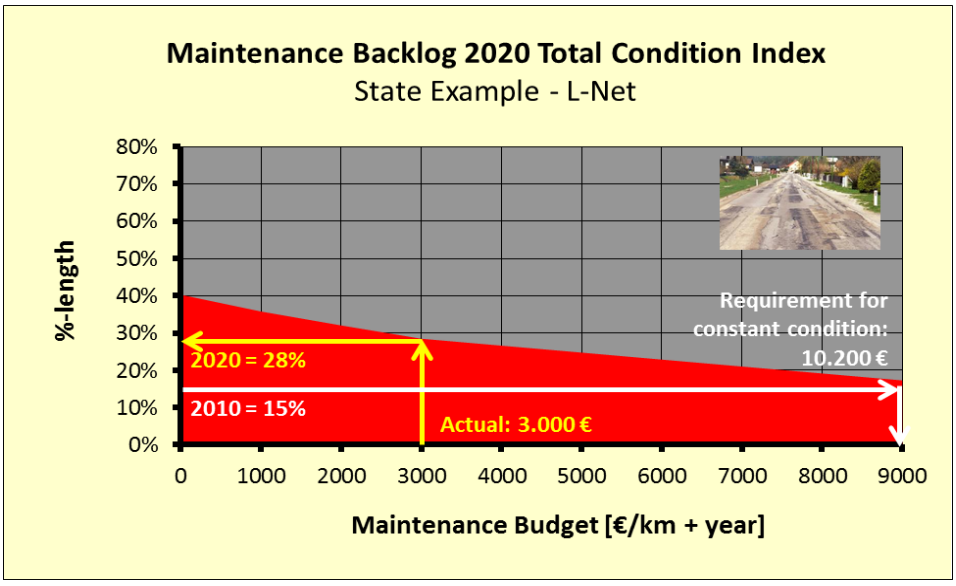

Figure 7: Backlog TCI in relation to available budget, L-net of example state

From Figure 7 it can be concluded that

- Keeping the actual annual average maintenance budget for this subnet of 3,000 €/km and year results in an increase of the backlog from 15% in 2010 to 28% in 2020
- To keep the actual condition (15% backlog) until year 2020 approx. 10,200 €/km and year would be necessary (additional requirement 240%)
- To secure a backlog of 20% in 2020 approx. 7,500 €/km and year would be necessary

3.2.2 Results based on the structural index

The condition distribution of the Structural Index SI for both subnets is shown in Figure 8. Here it can be seen, that the condition of the L-net is rather worse than that of the B-net. This is contrary to the comparison of the Total Condition Index (see Figure 4)

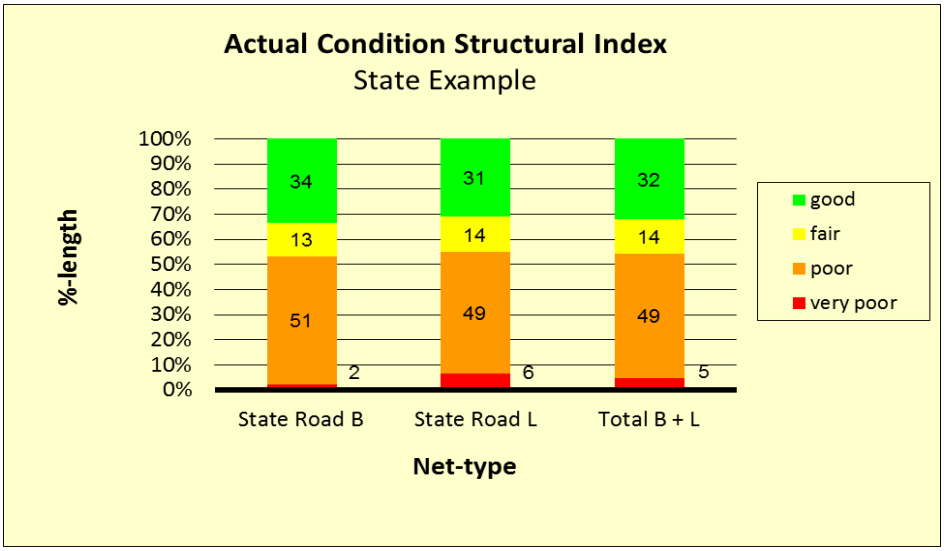

Figure 8: Condition distribution for the structural Index SI for the example state

The result for the evaluation of the maintenance backlog (backlog length) SI for the total road network in relation to the available budget is shown in Figure 9.

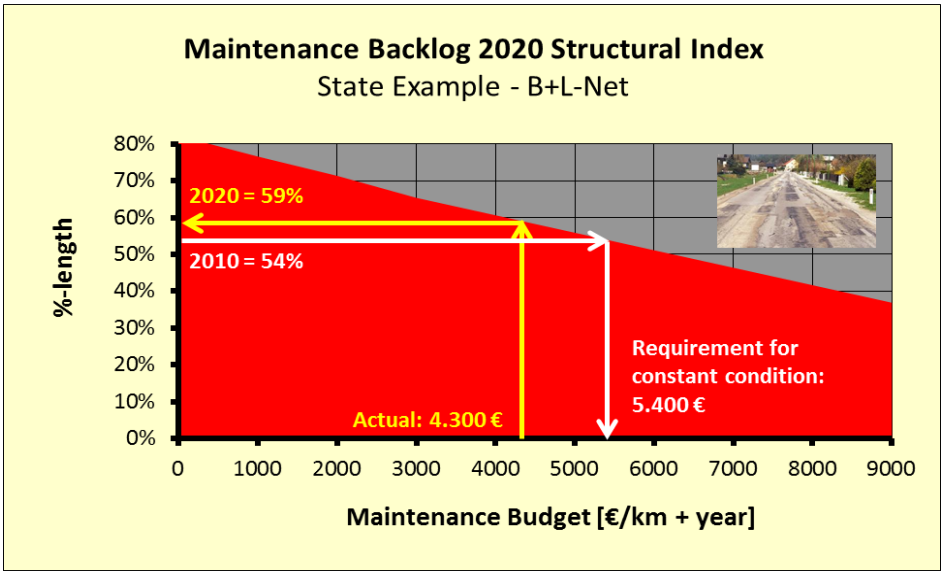

Figure 9: Backlog structural index in relation to available budget, total road-net of example state

From Figure 9 one can see that

- Keeping the actual annual average maintenance budget of 4,300 €/km and year results in an increase of the structural backlog from 54% in 2010 to 59% in 2020
- To keep the actual condition (54% backlog) until year 2020 approx. 5,400 €/km and year would be necessary (additional requirement 26%)
- To secure a backlog of 50% in 2020 approx. 6,200 €/km and year would be necessary

Here also it is interesting to differentiate between the two categories of state roads. The results for the B-net are shown in Figure 10, while Figure 11 presents the results for the L-net.

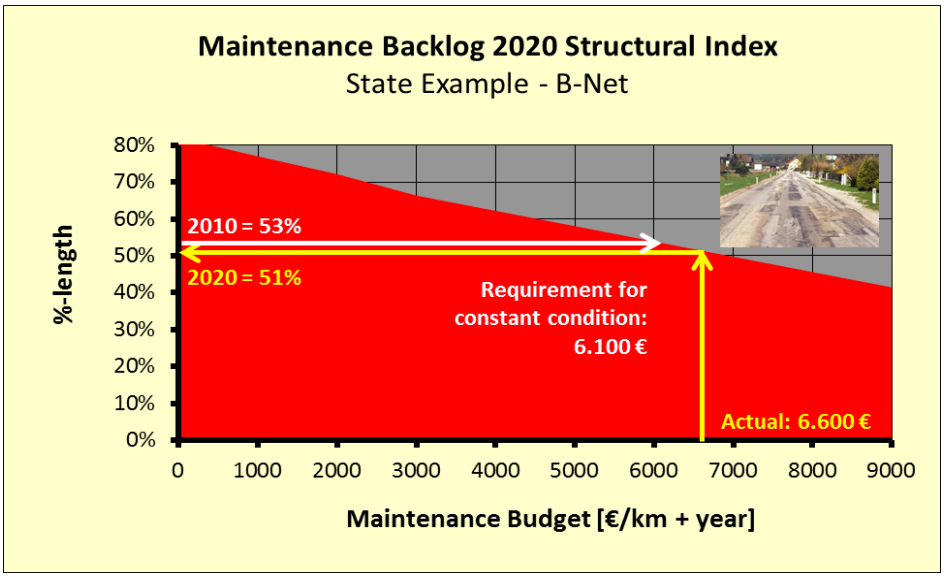

Figure 10: Backlog of Structural Index in relation to available budget, B-net of example state

Figure 10 shows that

- Keeping the actual annual average maintenance budget for this subnet of 6,600 €/km and year results in a decrease of the structural backlog from 53% in 2010 to 51% in 2020
- To keep the actual condition (53% backlog) until year 2020 approx. 6,100 €/km and year would be sufficient (reduced requirement 8%)
- To secure a backlog of 50% in 2020 approx. 6,700 €/km and year would be necessary

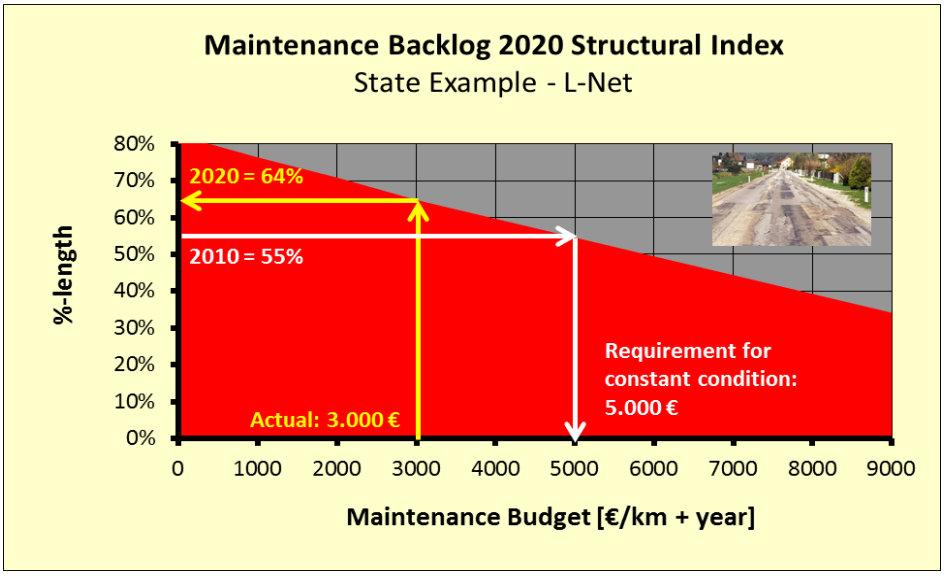

Figure 11: Backlog of structural Index in relation to available budget, L-net of example state

From Figure 11 one can see that

- Keeping the actual annual average maintenance budget for this subnet of 3,000 €/km and year results in an increase of the structural backlog from 55% in 2010 to 64% in 2020
- To keep the actual condition (55% backlog) until year 2020 approx. 5,500 €/km and year would be necessary (additional requirement 67%)
- To secure a backlog of 50% in 2020 approx. 5,900 €/km and year would be necessary

3.2.3 Conclusion for the example state road net

Looking at the total network of the state one can see that with the actual annual budget it is not possible to keep the maintenance backlog for the Total condition index in the same level until year 2020. To reach a target value of 20% backlog doubling of the budget would be necessary. The results for the two different sub-nets show that for the envisaged target value of 20% in 2020 for the TCI-backlog an increase of the given sectorial budget for the B-net of 21% and of 250% for the L-net would be necessary.

The evaluation of the Structural Index shows clearly higher backlog values than for the Total Condition Index. This is an indicator for the fact that in the past maintenance measures have been limited mainly to surface repairs and have neglected structural improvements. On average an increase of the actual budget of 44% would be necessary to secure a rather poor but realistic target value of 50% structural backlog. For the B-net this target value could be reached more or less with the given actual budget. However, in the L-net the situation is worse. Starting from a rather good value of 55% structural backlog, with the given low actual budget this value would increase to 64% in 2020. A target value of 50% backlog would demand an increase of the annual budget by 97%. In any case an increase of the budget for the L-net should be realized, be it by increasing the total available budget or by redistribution from the B-budget to the L-budget.

4 SUMMARY AND CONCLUSIONS

Commonly financed by the Austrian road administrations a study of the maintenance needs for the Austrian state road network was conducted. The aim of this study was to provide on a detailed and scientific basis simple and clear figures about the necessary budgets for the structural maintenance. Thus it could be shown for the total Austrian state road network that the pavement condition deteriorates from a backlog length of the Total Condition Index of 22% in 2010 to a value of 27% in 2020 if only the actual budget is available. To keep the actual situation until 2020 an increase of the annual maintenance budget by 40% would be necessary, to reach even a better target value of 20 % backlog length would need an additional budget of 46% compared to the actual one.

The actual asset value of the pavement structure is only about 50 % of the value for new construction. This also shows the necessity of sufficient means for the structural maintenance.

Looking at the detailed results for one example state one can see the big backlog in the Structural Index. This is a clear indicator that in the past due to the limited financial means the structural improvement of the road net was neglected. This is especially true for the state road with a lower net-function, so called L-roads. For these roads the maintenance budget should be increased by almost 100% to secure the rather poor but realistic structural backlog of 50%.

All these figures and values will form an important basis for the discussion of the state road administrations with their responsible bodies for finances. I can be hoped that the clear demonstration of the consequences of insufficient maintenance budgets will lead to a respective revision of the state budgets even in times of general austerity measures.

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