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Application of Pavement Management Systems for Optimisation of Road Maintenance also Using Thin Pavements and Surface Treatments

0. Summary

PMS is today used by many Western European road authorities for optimisation of road maintenance. In connection with the optimisation calculations thin as well as thick pavement types are calculated in the same calculation. This paper will describe how especially thin pavements can be treated in a technically and economically objective way in a PM System.

On the basis of the traditional necessary registration of condition data, the influence of roughness and bearing capacity on calculations will be discussed as well as the necessary adaptation of the deterioration models with which the system is working. Finally the paper will be dealing with which calculation parameters will be required if thin pavement structures should be included in an optimisation equally with thicker pavement structures.

The paper will give practical examples on calculations carried through in RoSy PMS - a PM System which is widespread in Western and Central Europe, Central Asia and which among other things can handle models from HDM III as well as HDM IV combined with Western European Maintenance practice.

1. An economically objective optimisation requires qualitative data

An economic optimisation of a road network’s maintenance is normally based on financial mathematical calculation methods. These methods are among others known from the World Bank’s optimisation models HDM III and IV and has also been incorporated into RoSy®. It is common knowledge that a certain amount of objective data on the road network must be availabe before an objective optimisation can be calculated. The data basis mentioned in this paper is not complete and should therefore be seen solely as examples.

1.1 Inventory

Data on lengths and widths of a road network and hence areas is a must, but also knowledge on pavement structure and sidings (verge, ditches etc.) may be useful and of particular interest when focusing on the possibilities with thin pavements in connnection with road maintenance. This is not least due to the fact that thickness and type of the existing pavement as well as the height limitations may have a considerable influence on the selection of the optimum maintenance strategy. Figure 1 shows an example on data in the layer record in RoSy BASE - the road database of RoSy®.

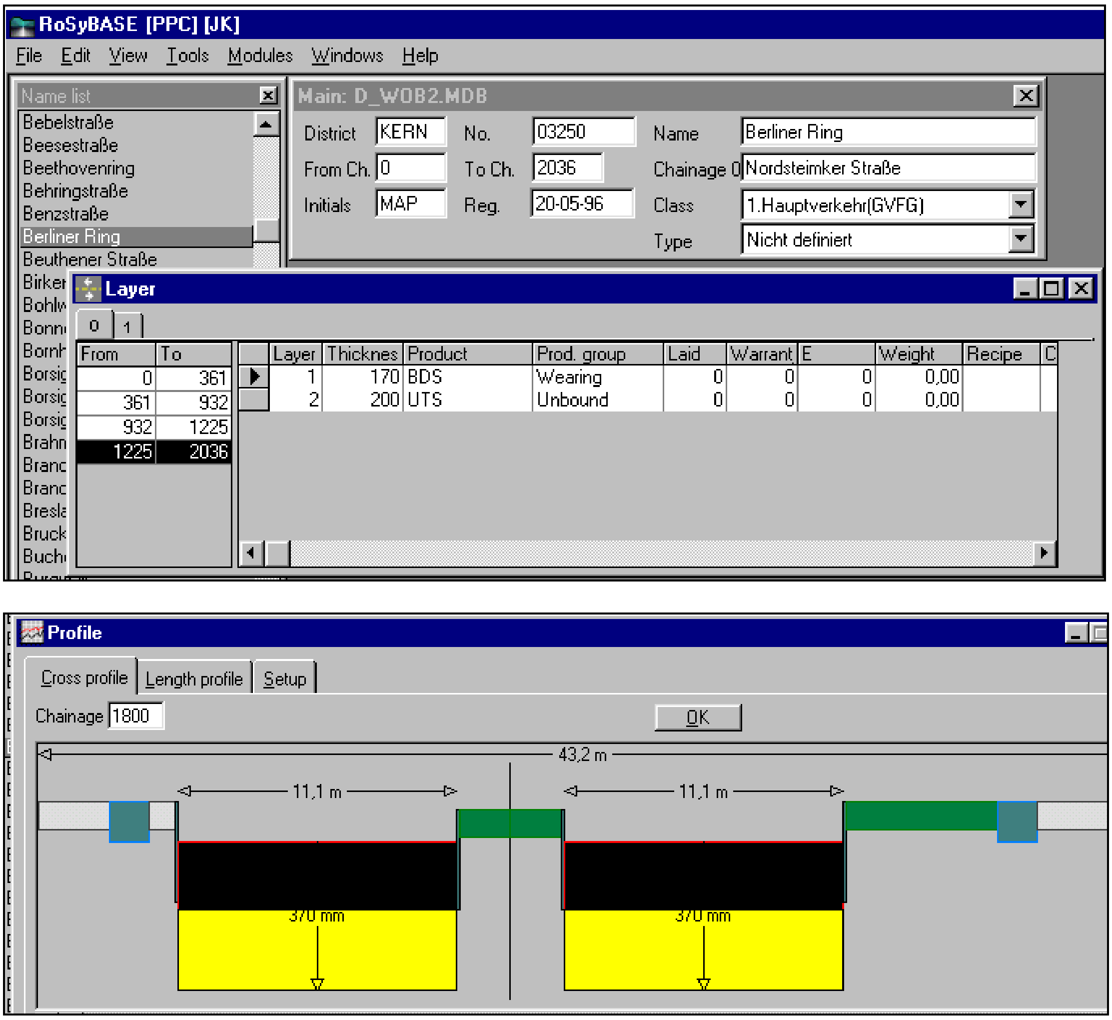

Figure 1 (Example from Layer Record

1.2 **Condition survey**

An economic calculation of the optimum maintenance effort on a given section can only be carried out on the basis of a more detailed knowledge of the present condition of the road surface and the strength of the road construction (bearing capacity). (see also section 3).

1.2.1. **Damages**

For RoSy it applies that the surface parameters and recording of conditions that apply to the present road network or if required to the present pavement type may be chosen freely. Figure 2 gives an example of data on a specific road section with a flexible asphalt pavement from the Damage Details record of RoSy BASE.

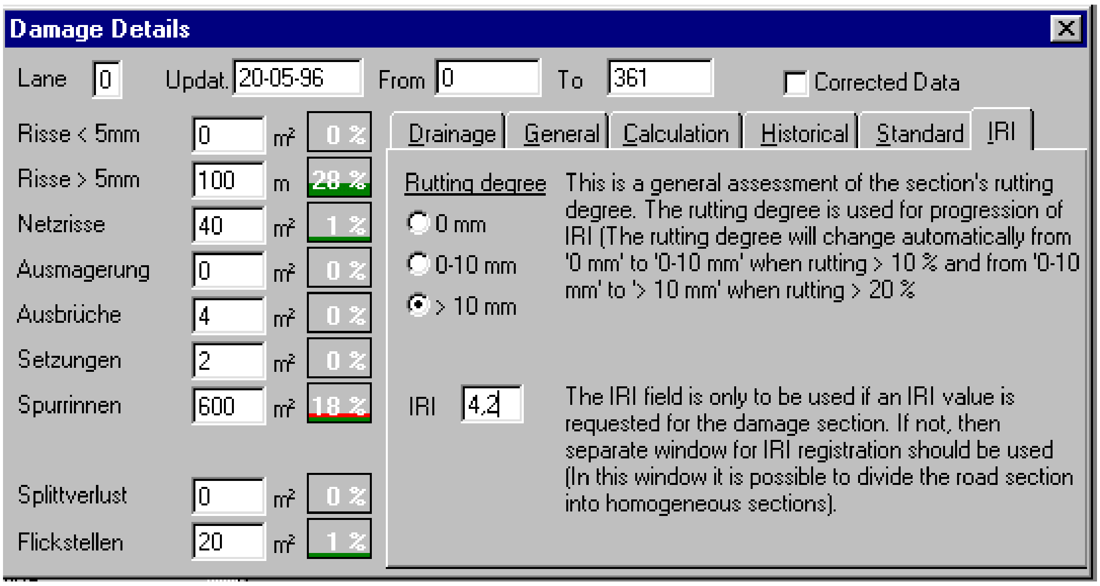

Figure 2 (Example from the Damage Details Record with IRI

1.2.2 Roughness

Information on the roughness of a road network is mainly of importance to the calculation of the structural deterioration of the road network and the calculation of the costs (Vehicle Operation Costs - VOC) that the users are involved in when using the roads. With RoSy it is optional whether one wishes to calculate with or without using VOC. Figure 2 gives an example of the measured roughness of a given road section expressed in IRI.

1.2.3 Bearing capacity

Without any knowledge of the bearing capacity of the road network an optimisation calculation will often result in a calculation of a wrong maintenance strategy. This is not the least a fact when operating with thin pavements like e.g. surface dressing. Figure 3 gives an example of data from the Bearing Capacity record of RoSy BASE.

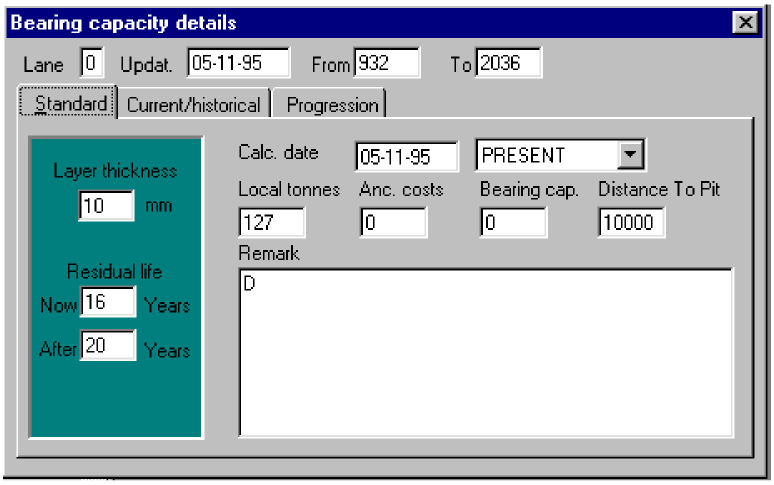

Figure 3 (Bearing Capacity Details)

2. Deterioration models

Deterioration models are necessary in a PMS if life cycle cost optimisations of the maintenance is required. RoSy is capable of calculating with horizons of up to 100 years, but 20 years is the most frequently used horizon. Each individual model will react automatically to historical data, which means that the more data stored about the individual road sections the better prognoses for the future development and the better RoSy's optimisation calculations will be. Figure 4 gives an example (graphically) of one of the deterioration models in RoSy PLAN.

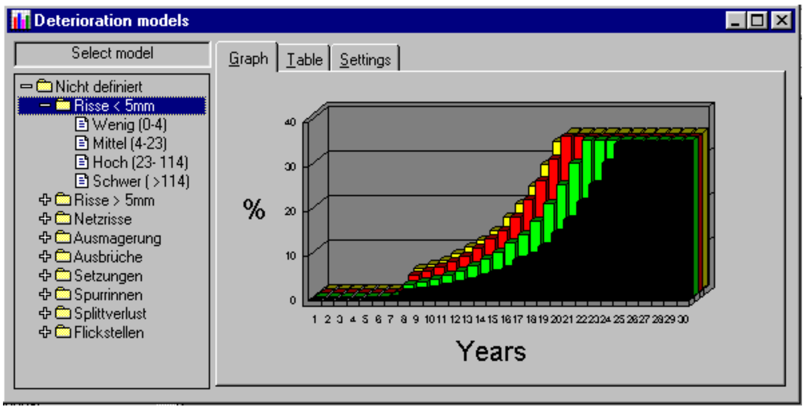

Figure 4 (Deterioration model)

3. Calculation parameters

Conditions for the calculations to be carried out are some of the most important issues in a Pavement Management System (PMS). Due to the totally open structure of RoSy, it is possible to make practically all the conditions that a road authority could wish. Figure 5 gives examples from the Product detail record of RoSy and indicates which restrictions could be relevant when choosing e.g. surface dressing.

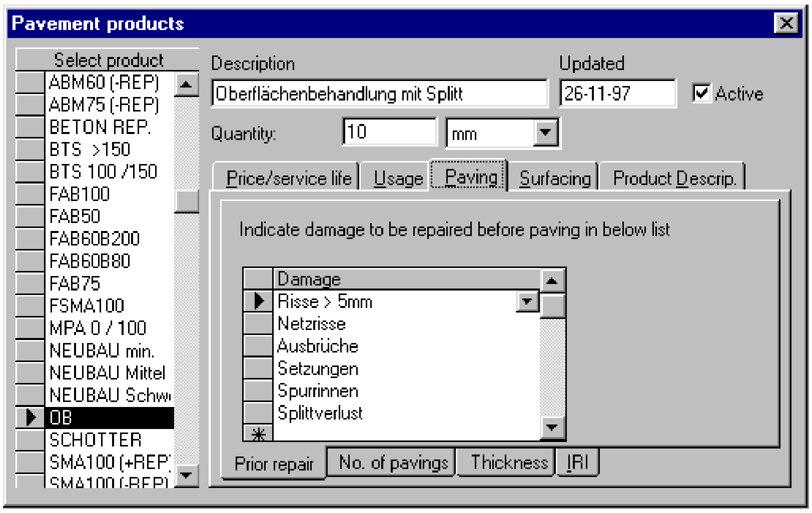

Figure 5 (Cold Asphalt Pavement Products)

4. Calculation with RoSy PMS

Knowing the road network and its condition (in RoSy BASE), the required deterioration models and the methods and products available, it is is now possible to make an objective economic calculation of which maintenance combination is the most optimum (with RoSy PLAN). The only limiting factors for combining repairs with thin as well as thick pavements are the rules (product requirements) set up by the user for each method/product (in the product record - see also section 3). Thus, the number of possible combinations depends solely on the limitation of the individual products and the number of years for which the calculations were made. Figure 6 shows how a combination calculation may be conducted. The combination which for the given time horizon gives the absolutely lowest costs expressed in NPV (Net present value) or gives the highest return on the invested funds expressed as IRR (Internal Rate of Return) may then based on an objective view point be regarded as the optimum one. See also figure 7.

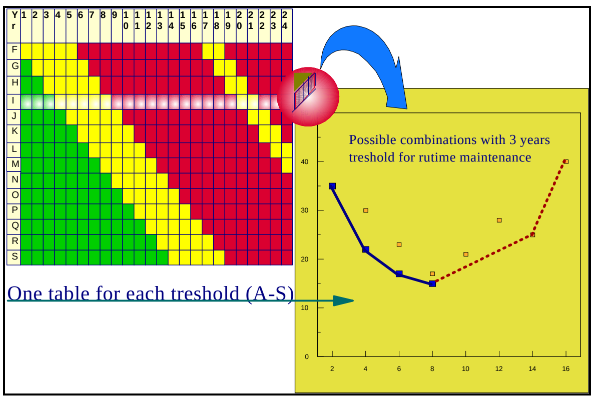

Figure 6: Graphic presentation of calculation combinations

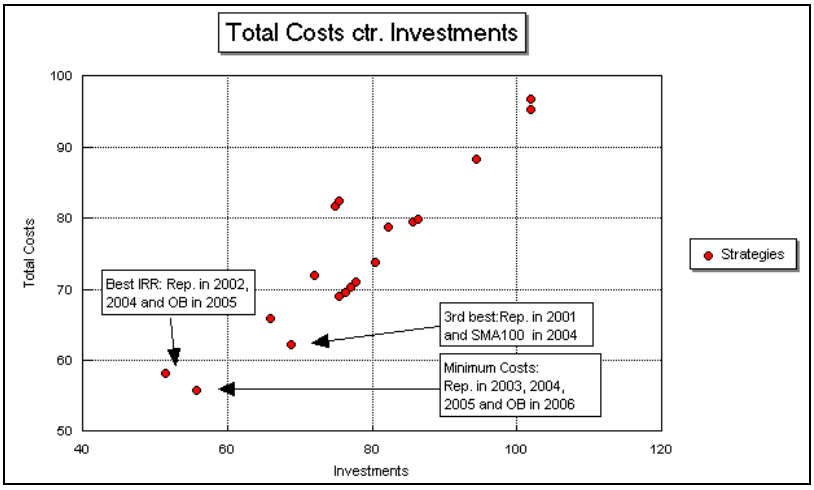

Figure 7 Examples on Net Present Values (NPV) of selected maintenance strategies (20 years) for a given road section

4.1 Examples and results from calculations

Below series of figures gives a brief introduction to how an optimisation is carried out in RoSy.

The wished calculation conditions are set up in the calculation wizard shown in figure 8

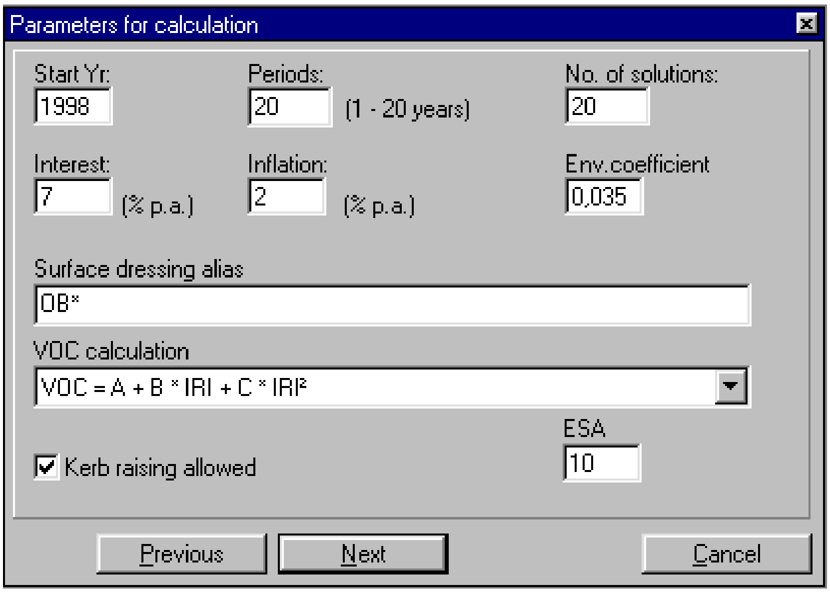

Figure 8

The calculations are carried out automatically as all possible combinations are calculated (see figure 9) and the optimum maintenance combination is found according to the principle shown in figures 6 and 7.

If there are any budget limitations, an iterative process will be carried out securing that the optimum solution is found even with such limiting conditions (e.g. as indicated for the first 5 years, see figure 10).

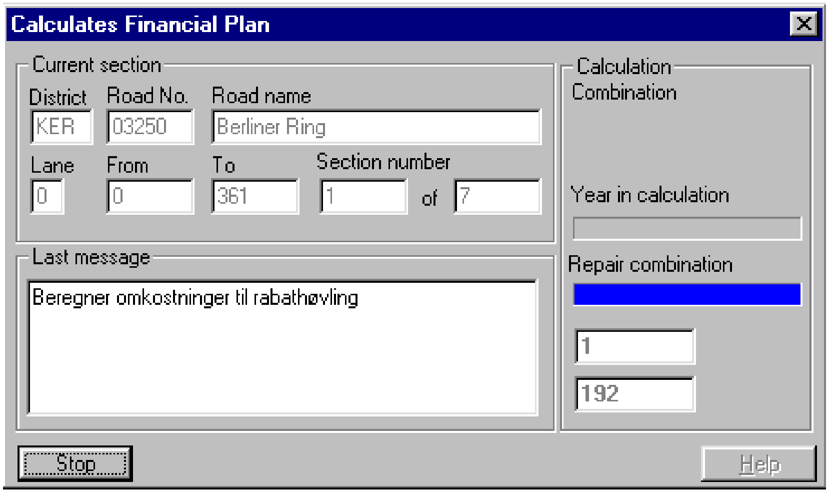

Figure 9

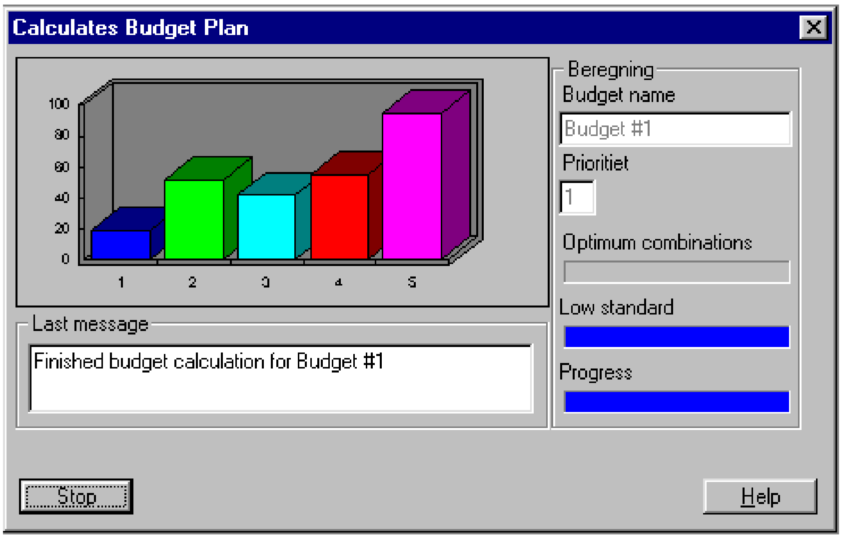

Figure 10

Printouts may be ordered/made as required. See figure 11

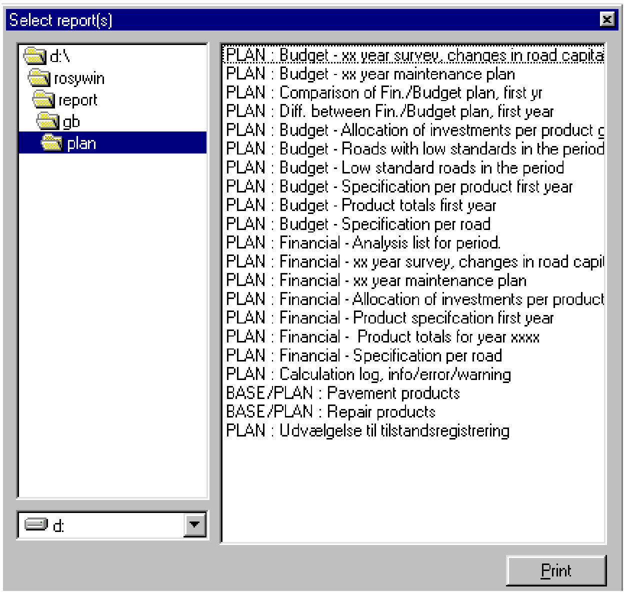

Figure 11

5. References

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5. Kristiansen Jørn, 1995. **Use of PM System to Optimize Choice of Right Maintenance Strategy**. Second International Conference on Road & Airfield Pavement Technology, Singapore.