DATA COLLECTION FOR PMS USING CAMSURVEY

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ABSTRACT

Every year millions are spent on maintenance of road networks in municipalities around the world. In order to optimise the road maintenance, it is important to strategically plan the maintenance. Pavement Management Systems (PMS) are used in combination with graphic presentation of data relating to a road network.

RoSy® PMS was first developed in 1982 for one municipality. It was such a success that the neighbouring municipalities wished something similar. The data was then collected on a paper protocol and had to be typed into the database manually. As the system spread the demand for a more powerful data collection system has arisen, as well as for the quality and quantity of data collected. The quality of the results calculated by any PMS is directly related to the quality of the data input, i.e. the data from the survey. In 1999 a new survey system, CamSurvey, was developed. With this system it is possible to register the defects and other features on a touch screen when driving along the road. In combination with GPS measurements the different defects are positioned on the map. Furthermore, the exact positioning of the defects in combination with bearing capacity measurements with Falling Weight Deflectometer (FWD) provides an ideal base for development of deterioration models.

The present paper describes the CamSurvey data collection system, and the advantages of combining the survey with GPS measurements. CamSurvey is currently used for data surveys for PMS. The collected data are stored in a database. The development of different defects is calculated from deterioration models and an economic optimisation is made of the road network maintenance based on financial mathematical calculation methods.

The survey system is intended for both road authorities and municipalities around the world, which makes heavy demands on the flexibility of both the PMS and the survey system used. CamSurvey is especially designed to manage different set-ups for data collection adapted to the demands and needs of the many users.

1 INTRODUCTION

Road maintenance is expensive and therefore it is important to plan the maintenance well. Maintenance planning can be performed at many different levels. The simplest way is when one person has knowledge about an entire road network and plans the maintenance based on his own opinions of the condition of the individual roads of the road network. This method is fairly manageable when the road network is small but vulnerable as it dependents on one or a few persons. Next level can be when geometric data on the road network and the condition of the roads is collected and stored in a database accessible to several people. The maintenance activities are based on this data and personal knowledge of the individual roads. The most sophisticated way of planning maintenance is when a proper Pavement Management System (PMS) is used. The PMS should include both data on the roads, i.e. geometric and traffic data and on their condition, i.e. defects, bearing capacity, etc., as well as functions for the maintenance planning based on the data. The PMS is accessible to different people and thus this method is less vulnerable. However, a sophisticated PMS is not enough for successful maintenance planning. The collected data has to be representative for the road geometry and condition.

The data quality depends on both the person/persons performing the inspection and how the data is described. In order to improve and enhance the mode of how different defects can be described and stored in the PMS database, an inventory system called CamSurvey was developed in 1999. The use of this inventory system also proved to simplify and speed up the inspection work. In combination with bearing capacity data and positioning with Global Positioning System (GPS) a good base for maintenance planning and decision is obtained.

The objective of this paper is to describe the inventory system and the benefits of using the system. Experience from projects where CamSurvey has been used for data collection is briefly described and evaluated.

2 THE CAMSURVEY DATA COLLECTION SYSTEM

Condition data collection of a road network can be performed manually, semi-automatically or automatically. The different types are suitable for different accuracy levels, purposes and types of roads. Semi-automatic systems are suitable for data collection for municipal road networks when the purpose is to get an overview of the condition of the entire road network and for PMS planning. However, the drawbacks of semi-automatic systems have been that the surveys are more time-consuming than automatic surveys and less detailed than manual surveys (Offrell 2000). The purpose of the CamSurvey data collection system was to develop a semi-automatic system that could collect data faster without reducing the accuracy level. On the contrary, it was desired to collect data described in more detail.

The CamSurvey data collection system was developed on the basis of experience gained from a semi-automatic data collection system called Nordic and manually performed inventories where the data was written on paper protocols based on a standardised inspection guide.

The Nordic system was written for DOS and used a point-board connected to a digital trip meter. The defects and geometric features where represented by different codes and pointed into a position on the road using the point board. The registered features are shown by codes in DOS on a separate computer screen. The Nordic inventory system made it possible to position defects and geometric data along the road. However, the system is somewhat complicated to use and the inventory is time-consuming. Furthermore, the codes

make it difficult to see, whether the registrations are made properly and to detect errors. The system is less flexible and thus more difficult to adjust for new features etc.

Manual registration of data on paper protocols is normally less detailed and errors may arise while the data is transferred to a computer database. The speed of the inventory depends on both the data collection and the data transfer. It is possible to check the inspected data easily but with a lower degree of detail, simplified descriptions of defects are necessary and the results from the PMS are less reliable and more generalised.

This experience formed the basis of the decision to develop a new and more sophisticated inventory system, CamSurvey. The system is windows based and uses a touch screen connected to a digital trip meter or a GPS. Figure 1 shows the touch screen and it's mounting in the vehicle.

Fig. 1: The touch screen is mounted in the vehicle so that the screen is visible and easily accessible from the driver's seat.

When an inventory is performed a sketch of a road is visualised on the touch screen. When the inventory is started, the road starts to move in the same pace as the vehicle and it is possible to position geometric and distress features exactly along the road as well as approximately across the road width. All information is gathered on the same screen, which makes it easy to follow in the survey process. Figure 2 shows a screen image for collection of geometric features, e.g. verges, ditches, crossroads, widths, etc.

Fig. 2: Screen image of the CamSurvey data collection system showing geometric features positioned along and across the road.

Different icons represent the different types of defects. When, for example, a crack occurs on the road, the crack icon is touched and dragged onto the road area. When the crack disappears the icon is again dragged out from the road area by touching the icon with a finger. When a quality control is performed it is possible to drive along the road and watch the surveyed image on the display simultaneously. Figure 3 shows an example of a road view visible on the screen when a condition survey is performed with CamSurvey.

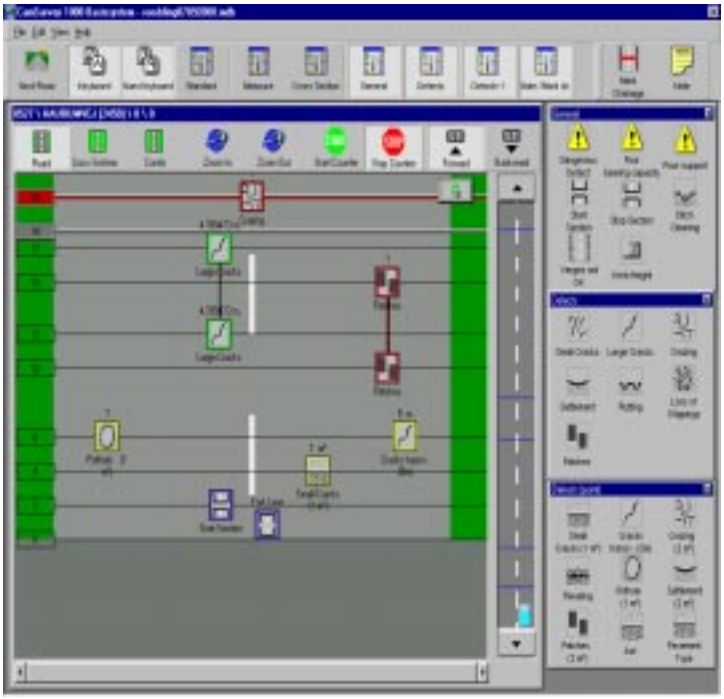

Fig. 3: Screen image of the CamSurvey data collection system showing geometric and distress features positioned along and across the road.

The registered data is automatically imported to the PMS database where it is processed by the calculation algorithms in order to receive prioritisation between different road objects based on optimisation calculations (Kristiansen 1995).

2.1 CamSurvey in combination with GPS

The standard CamSurvey data collection system uses a digital trip meter to position the features along the road. Through a combination with Global Positioning System (GPS), the coordinates as well as the position along the road can be established. This is applicable for both geometric and distress features. The features can then be presented on a map of the road network. The map is often used both in daily maintenance and to create general or specific views of the road network. For example, analyses can be made taking both geometric, traffic and distress data into account and work sheets can be delivered with exact positioning of defects for repair and other maintenance measures. Figure 4 shows how positioned defects can be illustrated on a map.

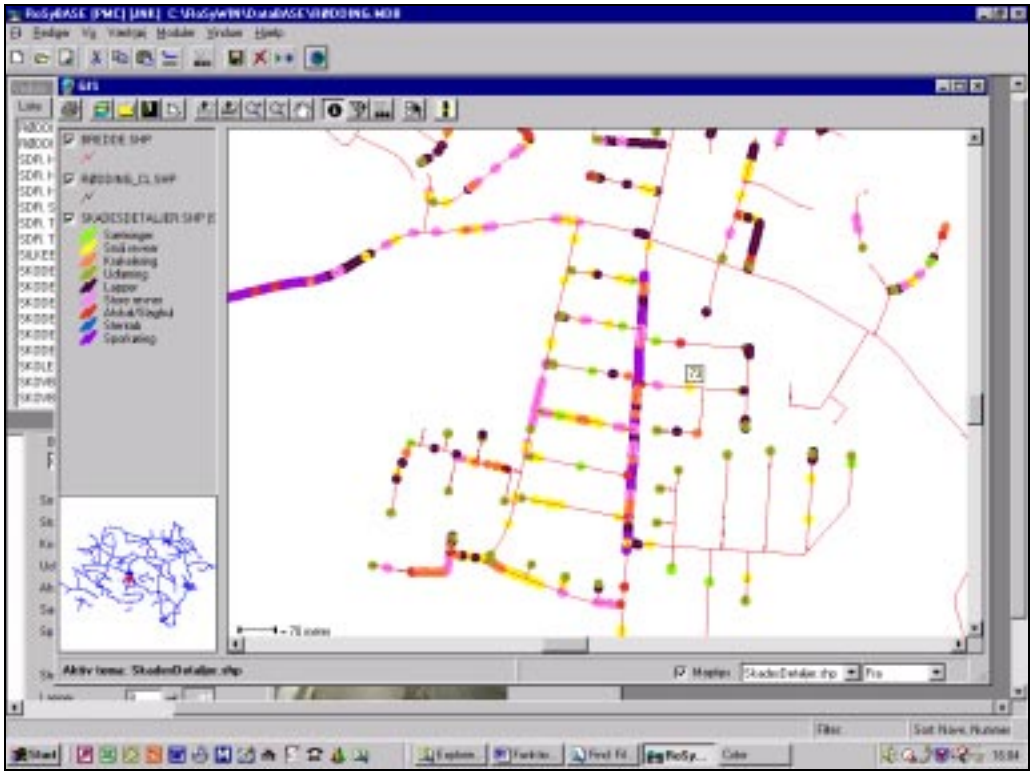

Fig. 4: The positioned defects can be illustrated on a map (Kristiansen 2001[2]).

2.2 CamSurvey in combination with FWD measurements

Sometimes data of the surface is not enough for maintenance decisions. When the bearing capacity of the road is insufficient, a more comprehensive maintenance measure or road reconstruction is necessary. By combining the inspections with Falling Weight Deflectometer (FWD) measurements, a thorough commission of the need for maintenance is received. The detailed description of defects and geometric features together with an assessment of the existence of bearing capacity problems makes it easy to find the road sections where bearing capacity measurements are advisable. The data from FWD measurements are also of value for the development of deterioration and prediction models (Kristiansen and Nielsen, 1990).

2.3 Development of deterioration and prediction models

Since 1989, data from FWD measurements and condition surveys on test sections have been used to develop and continuously enhance deterioration and prediction models for different defect types. The models are based on visual condition surveys on 100 meter of each road. The registered defect types are:

- Loss of chippings (square meter)
- Winter patches (square meter)
- Rutting (square meter)
- Settlements (square meter)
- Potholes (square meter)
- Ravelling (square meter)
- Alligator cracks (square meter)
- Large cracks (meter)
- Small cracks (square meter)

The 100 meter sections were divided in ten 10 meter sections and the amount of the different defect types expressed in square meters and meters, respectively, were expressed in percentage of the road surface area and road length, respectively. From the distress development on the 10-meter sections, FWD measurement, traffic data, climatic data, etc., deterioration models were developed (Kristiansen 2001[1]). More than 150 entire road networks have been surveyed and used for valuation and further enhancement of these deterioration models and to develop prediction models. Figure 5 illustrates some examples of distress development from the test sections (Kristiansen 2001[3]).

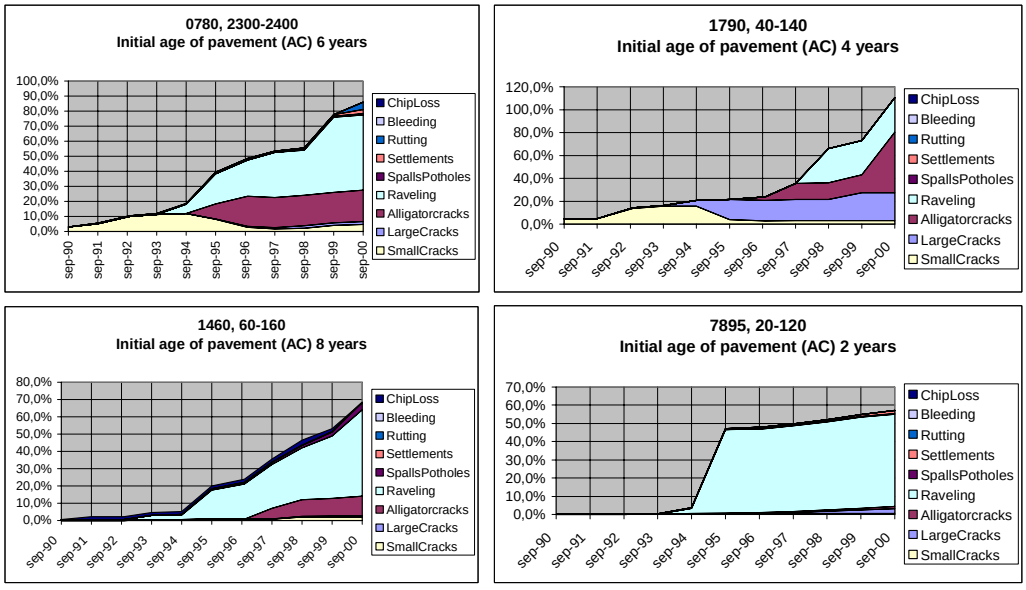

Fig. 5: Examples of development for different defect types on different test sections.

The prediction models are used in the PMS to predict future maintenance needs. The models are empirical and therefore different models have to be used for different types of road structures and different traffic and climate conditions. To further develop and enhance the prediction models, it is necessary to analyse the development of each individual defect. If the defects are not positioned it is impossible to distinguish if it is one defect that have become larger in extent and severity or if additional defects have appeared on the same road section. Consequently, the exact positioning of distress data is essential for development of good deterioration and prediction models (Kristiansen 2001[1]).

In the next 6 years, all road networks using RoSy® PMS for strategic maintenance planning will be surveyed with CamSurvey resulting in the fact that thousands of roads in more than 150 road networks will be surveyed with the CamSurvey data collection system. Each individual road will be inspected between one and three times depending on the condition of the road. With the new inventory system, each defect is described in more detailed and exactly positioned along the road. A large amount of data with positioned defects makes a new generation of enhanced prediction models possible.

2.4 Benefits from the new inventory system

Some of the benefits from using the new inventory system are:

- Better basis for development of deterioration and prediction models
- Better basis for prioritisation of maintenance
- Informative presentation material
- Enhanced quality control
- Comparison with and shared experience from 150 other road networks
- Analysis taking both geometric, traffic and distress data into account
- Work sheets can be delivered with exact positioning of defects for repair and other maintenance measures

3 PROJECTS WHERE CAMSURVEY HAS BEEN USED FOR DATA COLLECTION

The first project was surveyed with the CamSurvey data collection system in 2000. Since then, 14 entire road networks and 46 parts of road networks have been surveyed with CamSurvey. Tables 1 and 2 summarises the number of CamSurvey projects performed.

CamSurvey projects Entire road networks	Year: 2003	Year: 2002	Year: 2001	Year: 2000
Denmark	3	4	2	2
Norway	2	0	0	0
Germany	2	8	12	
Sweden	5	5	2	1
Ireland	0	0	1	0
Total	12	17	11	3

Tab. 1: Number of CamSurvey data collection surveys of entire road networks.

CamSurvey projects Part of road networks	Year: 2003	Year: 2002	Year: 2001	Year: 2000
Denmark	73	70	25	0
Norway	18	20	15	0
Germany	4	3	1	0
Sweden	11	6	6	0
Ireland	0	0	0	0
Total	106	99	46	0

Tab. 2: Number of CamSurvey data collection surveys of parts of road networks.

3.1 Experience and evaluation

The large quantities of data made the original system rather slow and long start-up times between different road objects prolonged the survey time. The velocity of the program and the data process functions has thus been optimised. The modified system is capable of data collection also from major road networks.

It was found that a continuous training of the personnel was necessary. The system is sensitive to the way data is recorded and errors in registration have to be corrected before optimisation maintenance calculations with the PMS can be performed. A training program has been developed and the technicians meet for evaluation and training continuously.

The collected data is imported to the RoSy® database with a special import program. Some corrections of the data collection procedure have been necessary for a successful data conversion between the CamSurvey database and RoSy® database.

The system has been continuously developed for new projects with different desires for geometric features, e.g. street lights, road markings, road signs etc., and has been adjusted to condition surveys on footways. The system has proven to be flexible and easily adjusted to new features.

4 CONCLUSIONS AND RECOMMENDATIONS

Some of the conclusions from the evaluation of the CamSurvey data collection system are:

- Many benefits have been gained from the positioning of individual defects, e.g. better basis for development of deterioration and prediction models and for prioritisation of maintenance,
- An enhanced quality control is possible and easily performed.
- The system is capable of data collection from large road networks.
- The system is sensitive to registration errors and a continuous training of the personnel is necessary.
- The system has proven to be flexible and easily adjusted to new features.
- Successful transformation between the CamSurvey and the RoSy® PMS database is possible.
- Shared experience from more than 150 road networks will be gained in the next 5 years.

To further improve the CamSurvey data collection system, functions for automatic measurement of geometric features, e.g. kerb height, road width, etc. will be added. A camera filming the road view would provide additional information for the detailed decision process based on the calculated maintenance plans.

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