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SWIS - Germany's Road Weather Information System

1. Introduction

Germany's road weather information system, SWIS (Strassenzustands- und Wetterinformationssystem), is a joint project of the Federal Ministry of Transport, the 18 road authorities of the federal states, and the Deutscher Wetterdienst (DWD).

SWIS is regarded as an additional tool in order to improve the efficiency of road winter maintenance. The aim of Germany's road winter maintenance is to prevent ice formation (e.g. salting before rime formation) or to keep the time during which a road section is slippery as short as possible (e.g. in the case of snowfall).

In 1991/92 SWIS was started in one federal state, and in the season of 1995/96 SWIS was available throughout Germany as a nationwide system.

2. Design of the SWIS-network of road weather monitoring stations

In the past road authorities installed road weather monitoring stations at sites along the motorways prone to ice formation. A local road master was able to receive data only from those stations present within his road network of responsibility. He was able to check on the

current weather situation (in some cases he was able to save time and money by avoiding unnessessary control runs), but he had little information on the weather situation in the neighbouring road networks and on the development of the weather.

SWIS provides the possibility to combine all these single road weather monitoring stations into one uniform network. Data from a road weather monitoring station are transmitted automatically every 2 minutes to the local motorway depot. From there the data are given to a central SWIS-computer of the road authority. All data are then made available to all depots, hence, the local road master has current weather information from the entire federal state.

Road weather data are also transmitted automatically by the central SWIS-computer of the road authorities to the SWIS-computer at the regional offices of the Deutscher Wetterdienst, however, actual data are transmitted only every 15 minutes.

Within the SWIS-project standard equipment of the road weather monitoring stations has been defined. At a road weather station air temperature, humidity and precipitation are measured at a pole of 4 metres height, being placed about 1-3 metres next to the motorway. Experiences have shown, that sensors attached to the pole at a height of 2 metres are influenced by dirt and spray due to the turbulent mixing caused by traffic. At a height of 4 metres these influences are reduced. Comparisons have shown that air temperatures measured at a height of 4 metres do no differ significantly from those measured at 2 metres due to the turbulent mixing. At the same position a road sensor is installed in the middle position of the fast lane. This sensor determines road surface temperature, road conditions, and residual salt (or freezing temperature). Whenever possible, a sub-surface temperature measurement is taken additionally at a depth of 30 cm.

Within the communication network owned by the road authorities a standard communication protocol has been defined by the Federal Ministry of Transport. Communication between the SWIS-computers of the road authorities and of the Deutscher Wetterdienst uses public communication lines with standard protocol (FTAM) and standard data format (similar to a synoptic code)(Table 1).

Table 1

Code for Transmitting Road Weather Data

YYGGgg	day/hour/minute
CCCC	station identifier
111	identifier for the first section of data
	meteorological parameters
1sTTT	air temperature
$2sT_dT_dT_d$	dewpoint
3VVVV	visibility
5ddff	wind direction and speed
$7WRRK_r$	precipitation/amount/intensity
222	identifier for the second section of data
	road related parameters
$1sT_sT_sT_s$	road surface temperature at the standard position
$2sT_sT_sT_s$	road surface temperature at a different position
$3sT_uT_uT_u$	sub-surface temperature at the standard depth
$4sT_uT_uT_u$	sub-surface temperature at a different depth
$5hh/K_w$	depth of waterfilm/classification
$6mF/S_z$	manufacturer/technical status/ road conditions

example:

SH10:	data type: road weather data
010715:	issued at the first day of the month at 7:15 UTC
DWRH:	issued by the SWIS-computer located at Rüsselsheim (DWRH)

3 monitoring sites in Hesse with the following station identifier: L234,L236,L238

SH10 010715 DWRH

L234 111 10084 20032 34000 50815 71///

222 10075 2//// 30040 4//// 5//// 620/2=

L236 111 10087 20045 71///

222 10080 620/2=

L238 111 10103 20098 71//2

222 10123 20119 30087 40094 5///3 610/2=

3. SWIS road weather forecast products

It has been agreed upon that the local road master bears the sole responsibility of carrying out road winter maintenance. On the other hand, this requires that the forecaster at a regional office has to provide forecast products tailored exactly to the needs of the road master: these products have to be presented in a form easily to be understood; they should contain only information relevant to road winter maintenance, and should be issued at those times when decisions have to be made. SWIS does not provide the local road master with unfiltered meteorological information. However, SWIS does provide a) all meteorological information necessary for the road master and for the forecaster,respectively, and b) forecast methods relevant to road weather prediction.

At the 7 regional offices of the Deutscher Wetterdienst various detailed road weather forecast products are produced during a daily morning-shift. These forecasts serve two purposes: a) as planning aid for time periods of 1 to 3 days (management of personel, equipment, salting material), and b) as decision aid for time periods of 2 to 24 hours (daily road winter maintenance). Most products are issued on a daily regular basis. Road masters have learned to use this information not only for road winter maintenance but also to plan other road maintenance activities (Table 2).

In the case of critical situations during anticyclonic conditions (e.g. rime formation) the weather information supplied by the road weather monitoring sites will be sufficient in order to estimate the onset of ice formation. However, in the case of changing air masses with upcoming precipitation events which can lead to slipperiness, additional synoptic information is required. This can only be provided by a meteorological service. In that particular case, the Deutscher Wetterdienst issues road weather advices. They are issued about 2 to 4 hours in advance of such a precipitation event, in order to give the local road master enough time to take preventive measures. These road weather advices may be issued at any time. They update the regular forecast products released at an earlier time, which means that a road master has planned accordingly and his crew at the depot is waiting for the start of the spreading run.

Table 2

Road Weather Forecast Products as Part of Germany's SWIS

type of forecast	forecast area	forecast period	issued at
3 - day forecast	federal state	noon of the 1. day until noon of the 3. day	10 CET
general (24-hour-) forecast a) early morning	federal state	7 CET until 13 CET of the 1. day	7 CET
b) noon		13 CET until 13 CET of the 1. day	12 CET
detailed (24-hour-) area forecast	forecast area	13 CET until 13 CET of the 1. day	12 CET
road weather advice	region of a federal state	3 to 6 hours after time of issue	whenever necessary

4. Outlook

For the 1995/96 winter season about 130 forecast areas were defined; i.e. climatic regions (based upon mean precipitation amounts, mean air temperature) subdivided by 200 metre-altitude- intervals. For each of the forecast areas a 27-hour-forecast is produced including the parameters cloudiness, precipitation, wind, air temperature and, as results of the calculations of an energy balance model, road surface temperature and road conditions.

Since the energy balance model can only be applied to a single point of a road section, it is assumed that the results are representative for the entire forecast area. This approach is different to those pursued in other countries, where forecasts are produced for specific sites. It is well known that there are natural variations of road surface temperature along a road stretch which may easily amount to +/- 2 K due to local orographic effects, due to road construction types and due to traffic density. This fact supports our general agreement (as mentioned above) that it remains very important that the local road master has the final responsibility for road winter maintenance, because only he is aware of all these local peculiarities.

There may be different approaches to develop forecast methods for predicting road surface temperature and road conditions along road sections. Our current concept is to define site characteristics or route types according to surrounding landscape, road surface characteristics, road construction type, traffic density, etc.. With the help of road weather monitoring stations the characteristic behaviour of these types during different weather situations will be identified. Based upon that knowledge the energy balance will be adjusted to such site characteristics. During the 1995/96 winter season the DWD-version of an energy balance model is applied to 5 different site charachteristics. In addition, it is planned to develop statistical procedures and a topoclimatological model to take into account the local effects.