

# TECHNOLOGICAL SUPPORT AND POLICY FOR WINTER SERVICE IN THE CZECH REPUBLIC

Ing.Karel Melcher

Directorate of Roads and Motorways of the Czech Republic  
fax : 00420 5 41236311, e-mail : karel.melcher@brno.rsd.cz

Last decade, special attention is also in the Czech Republic paid to the sphere of winter service realisation. Financial expenses for winter maintenance are in recent years in the third part portion approximately of the total financial allowance for round-the-year activities of our road administrators. Last winter period, 1,8 billions of Czech crowns (i.e. 45 millions of USD) have been for example expended to the winter maintenance in spite of very moderate weather conditions. There is an understandably effort to make this costing as optimal and effective as possible.



Since 1999, the Czech Republic (CR) actively worked on the program called "COST 344 - Improvements to Snow and Ice Control on European

Roads and Bridges" in collaboration with European commission working in Brussels, which is responsible for scientific and technical research in the field of transport policy.

The program COST 344 is considered to be a specific type of an "association", which has to deal with problems of winter maintenance on the Europe-wide territory. In this context, the opening Memorandum of Understanding states that *"effective snow and ice control is a vital service for national governments in order to ensure, as far as possible, that road users can travel safely and with minimum disruption in very cold and severe climatic conditions. In order to provide this service, highway administrations have made substantial investments in services, infrastructure and resources .In addition to the impact on the area concerned, the effectiveness of these services can also impact on neighbouring administrations and states"*.

As for the COST 344 work group activity opening, the acquisition of the needed data (documents) of delegated representatives of individual countries ,considered for this purpose as fully competent executive representatives of given national territory, served namely among others as the basis.. The thing is that individual countries are considered as members of COST program instead of original institutions.



In this way, a network of experts that will be for a long period of time (until end of 2002 probably) firstly involved into sphere of present procedures, technologies, equipment, materials and other products finding was formed and the obtained information will serve the basis for "data base" establishment for the purpose of the best practice specification for different areas in the Europe .

As subsequent step, further recommendations for future research and development of directions for integration of specified winter maintenance methods for highway administrators will be fixed as well as their application on the whole European territory. This matter is also mentioned in the Memorandum as a significant contribution for accomplishment of stated goals of the Transport European Road Network (TERN), as established by Decision No 1692/96/EC of the European Parliament and of the Council of 23<sup>rd</sup> July 1996.

## 1. Basic facts from the sphere of equipment.



Qualitative progress is focused on new advanced technology enabling full use of wetting technology. Naturally, application of the technology is related to adequate machines and equipment. In the winter period 2000/2001, already 665 spreaders enabling full use of wetting technology have been put on by road administrators.





Within the framework of the complete COST 344 program, the Czech Republic also solves an actual national target focused on the sphere of equipment and preliminary called “Elimination of icy patches and ruts in the compacted snow layer on the road surface”. During the winter season 2000/2001, an implement mounted on clamping plate of all commonly used all-purpose carriers has been developed in close co-operation with a Czech producer of road building machines. The device is surprisingly simple and useful and does not need a special drive.

Functionality of ice cutting is only provided with passing of the carrier itself. Total width of the device is 2 400 mm, high of 920 mm and the maximal thickness of ice-layer cut ranges according to local conditions from about 50 to 100 mm. As for the running winter season, reference tests with all up to now used equipment destined for given technological activities are planned.

## **2. Basic facts from the sphere of spread technology**

Proportion of road sections treated with chemicals increases along with maximal salt wetting technology extension. Trends of development do conclusively demonstrate a controlled progress in winter serviceability in the sphere of used technologies. During 1993 – 1998 period, a research study, aim of which was pursuing of selected parameters in road serviceability ensuring with use of thawing agents, i.e. salts, has been conducted by road administrators.

Analysis of obtained data has clearly proved that practical use of wet salt technology is to bring under our weather conditions the expected results. For example, average dosage by  $m^2$  has been stabilised during the last surveyed winter season on  $19,63 \text{ g/m}^2$  with dry salt spread and we take the decrease of the average dosage by 15 % with wet salt application, i.e. on  $16,63 \text{ g/m}^2$ , as a very positive aspect. At a one glance it seems to be only very small and negligible weight difference. Still, when evaluating the total savings resulting from application of the technology, we can demonstrate that during five surveyed seasons at minimum 25 000 t of chemicals have been saved, the value of money of which is approximately 40 mil. Czech crowns (1,1 mil. USD).

## **3. Sphere of other auxiliary support systems and equipment**

the Czech republic has seen, namely in recent years , expansion of various support systems and equipment application in decision making of managers. Wider use of these systems and equipment improve effectiveness of the whole winter service performance. For your information, three model cases have been chosen.

### **3.1. Thermal mapping of the motorway network.**

During winter season 1997/98, thermal mapping has been started on the main motorway network of the Czech Republic in total length of 430 km. Next seasons, the mapping has continued on the remaining motorways and, in addition, some selected expressways have been mapped. Last winter season has also seen the mapping of selected two lane roads. In 2001, the total length of mapped roads has reached 1 037 km of roadways .

#### **3.1.1 General information on thermal mapping**

Thermal mapping is first of all aimed at improvement of winter service on trunk motorways in the Czech Republic. Local prediction of pavement behaviour in situ of foreign producer measuring meteo stations is changed for an aerial network system with predictions of pavement surface behaviour in each climatic zone. Surprising discovery of the first season of mapping was that contrary to the expectation the most critical area from the point of ice formation has been measured at the Czech Republic – Federal Republic of Germany boundary area in the section of Rozvadov maintenance depot.. For all that, it was generally supposed in the frame of the Czech Republic topography that the most complicated section will be found on D1 motorway leading across the Bohemian-Moravian Uplands having features of a plateau.

The treated thermal maps were helpful to later optimum lay-out of road weather stations. Of principle, location of 12 main road weather stations has been proposed according to the given rule for each located climatic zone having two stations at appropriate site, i.e. one main station and one reserve station. In case of main station malfunction, the system is continuously able to provide with relevant forecasts on climatic zone in question.

In building the system based on famous European producer technology, low quality of telecommunication services on the Czech Republic territory remains always the critical point. As far as maintenance depots were informed via their own phone lines about data concerning only their locally corresponding meteo-stations (3 to 6 stations), the problems seemed to be easy managed. In the moment, when the system of 38 stations has been connected to one block and there was a possibility to download the situation on 430 km long section of selected motorways at any terminal workstation, it became evident that the unreliability in power supply and communication with individual stations is critical. In winter season 1998/99, the occurred malfunctions have become unacceptable thus following corrective actions have been adopted:

- a) *power supply of stations has been completed with circuit breakers, which do automatically repeated power supply switch on after timing switch out is made.*
- b) *data lines have been changed from poor-quality phone connection based on the Alcatel PCM out-of-date communication system to the VSAT satellite data connections.*

As a result of this, all power supply problems stopped and data connections have seen a qualitative improvement. Now we can make qualified prognosis of technical falling-outs reduction to 10% of previous state. In spite of this, we cannot entirely recommend VSAT data connections for limited functionality of the system within selected meteorological conditions, such as in case of heavy snowfall in combination with wet snow – rain. As a prospective technical transition, depending indeed on the telecommunications development in the Czech Republic, the use of ISDN lines is under preparation. Data channels of the lines make a reliable data transmission of capacity available.

The thermal mapping of motorways has also revealed a remarkable reality. Due to low altitude changes and very high traffic volumes, the motorways are namely generally heater than parallel roads of lower road classification level. Effectiveness of the thermal mapping system should among others come fully to light especially in the Cheb region (western part of our republic), where these days measured road network leaves flat country for mountains that borders on Germany. According to the information on winter service operations in this region, detection of at least 3 different climatic zones with independent local climate can be expected on a relatively small road network.

### **3.1.2. Application**

Winter service dispatcher will obtain 2 basic types of data about his road network as follows:

- *when hi can expect the minimal temperature on his road network*
- *where will be minimal values in the temperature spectrum near freezing point.*

According to the data, maintenance action can be planned in local and time level. Quality of a forecast is permanently compared in graphs, where the forecasts and actual measured values are plotted. Quality of forecast service can be assessed at the end of each night. The thermal maps are then completed with textual forecasts for 24 hours and for 2 to 5 days forwards.

An other improvement of the forecast service can be made with use of the ALADIN mathematical model of precipitation and cloudiness development being elaborated for Central Europe region purpose in the Czech Hydrometeorological Institute in the

frame of European international cooperation. Emphasis should be laid on that it not only concerns a simple output of information from precipitation radar but a forecast of precipitation areas and intensity of the precipitation for the whole territory of the Czech Republic. With progressive accuracy of the model, a prognosis for 12 hours forward describing with very high accuracy the weather situation development for 2 or 3 hours in advance can be made.

### **3.1.3. General conclusions**

We can declare that the defined progressive technology is in active use in the CR and it is only lack of many that hampers its state-wide application.

The final plan of thermal mapping in the CR, it is full covering of motorways and expressways as well as I. class roads. Last year, essential change of state administration for regional arrangement has been realized and in this context also some changes in ownership of road network have come to force. Considering that the roads of higher qualitative level evidently stay under direct central administration of government, the assigned target may be prospective even in the future.

## **3.2. Management information systems**

Road winter maintenance information system (IS) consists of a complex of program and data sources defined for support of road and motorway winter maintenance providing. Draft is made for a state-wide system on the basis of a uniform data base and unified methods for information processing.

The present version of road and motorway information system contains the following basic subsystems:

- *Meteorological information system*
- *Journal of winter maintenance*
- *Schedule of winter maintenance*

In the frame of future development of the system, a gradual addition of another modules is envisaged, the Evaluation of Winter Service, for example.

### **3.2.1. Meteorological information system for road winter service (MetIS)**

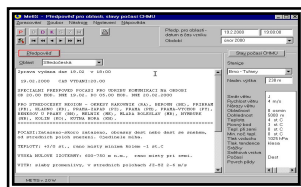
The system works on state-wide level and content of information is adapted to requirements of road and motorway winter maintenance in the Czech Republic with concentration to the road masters.

On the basis of many years of observations, the Czech Hydrometeorological Institute (CHMI) does differ 6 basic typical meteorological zones on the Czech Republic territory and these zones can be still divided into 13 sub zones in total.

Data base of the present version of system contains specialised reports being prepared at CHMI workplaces. The users have the following types of information at their disposal:

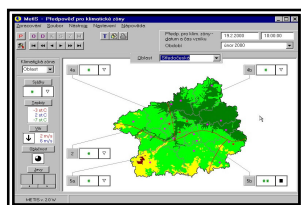
- Forecasts for regions

*Textual description of predicted weather development in the regions corresponding with former counties (this dissection is kept with respect to CHMI workplaces) Characteristics of meteorological phenomena is specified up to the level of individual districts, if necessary. The forecast is issued four time a day with validity for the next 8 or 10 hours.*



- Forecasts for motorways

*Textual description of weather development focused on the Czech Republic motorway network. It is issued four time a day for each motorway separately.. In case of longish motorways (D1, D5), the data are defined more accurately for single sections of motorways.*



- Forecasts for climatic zones

*Combination of graphical and textual description of predicted weather development being issued once a day with validity for next 24 hours at minimum. The forecast is developed for seven regions of the CR corresponding with former district territory. Individual meteorological quantities (cloudiness,*

temperature, wind, precipitation, dangerous phenomena) are displayed in well-arranged graphical form (synopsis) and furthermore, they are specified according to the so-called climatic zones, i.e. territory having similar character of weather for a long time.

- Reports on weather conditions at the CHMI workplaces.  
*The results of measurement and survey from the CHMI proper network of professional measuring stations are issued four times a day for the Meteorological information system users. It deals with data from 32 localities within the Czech Republic territory.*
- Records from the precipitation radar  
*Information of graphical character about precipitation development above the Czech Republic territory in hourly intervals.*

In addition, implementation of another type of information – user reports about weather conditions and road serviceability has been prepared for further winter seasons. Contents of the reports is drafted as follows:

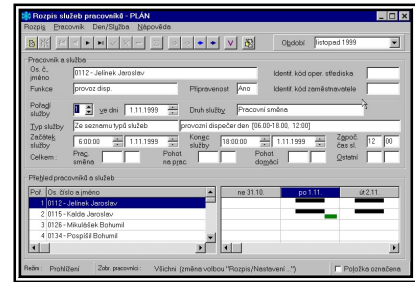
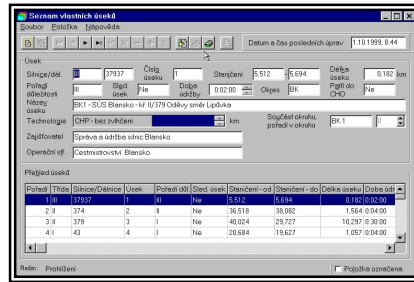
- Weather in regions  
*Structure and form of data including the other elements (factors) are similar to those of local weather, the contents relates, however, to the prevailing conditions in the whole region appurtenant to the road master. Considering that the Road Maintenance Administrations operate in the CR regions, a survey about weather conditions on the whole territory of our republic is being created by summarisation of individual reports.*
- Weather on the motorway sections  
*Summary is especially designed for weather observations on all motorways serving as backbone communication system. Data are treated by Motorway Administration and Maintenance Centres (MAMC), each of which being preoccupied with 40 to 50 km long section of the motorway. As for the contents and form, this survey is conform to reports about local weather and the weather in regions.*
- Local weather  
*Summary of data about cloudiness, temperature, wind, precipitation and hazardous phenomena in a particular locality, elaborated in a predefined tabular form. It usually relates to the situation at a site, where an dispatching of MAMC or RMA is situated, however, the road master is to record data even from the others localities for his purpose. An operator has a possibility to complete the report with a notice of any extent, in which he can precise data from the table.*
- Road serviceability in regions  
*Summary of the most important data about road serviceability on each existing district territory in our republic. The stress is putt on the part dedicated to the potentially dangerous localities as to bridges and sections in the woods, also winter maintenance actions are kept under review. The summary is elaborated at RMA dispatching centres.*
- Road serviceability of surveyed road sections  
*More detailed summary about road serviceability in regions focused on the information about selected network. The surveyed road sections are of road traffic important character. Elaboration of the report is carried out at winter maintenance dispatching centre of all RMA.*
- Road serviceability of motorway sections  
*Detailed information on particular motorway sections. Critical sites are stressed in similar way as for road serviceability in regions. Used terminology corresponds with specific needs of motorway winter service and also compatibility with corresponding data of road network is ensured. A report is prepared at dispatching centres of MAMC.*

As for further development of the MetIS, connections to local meteo stations and to data of road surface thermal mapping are assumed.

### **3.2.2. Journal of Winter Service software**

Priority of the „Journal of Winter Service” (JWS) software is given to the support and ensuring of managerial, documentation and information actions of dispatching workplaces of road winter services by RMA and SAMC. The program concept allows for:

- *Prompt and comfortable recording of current events like leaves and arrivals of vehicles, malfunctions of machinery, performance per route, loading of spread materials, incoming and outgoing messages, traffic accidents, etc., registered during dispatching duty.*
- *Work with information about weather and road serviceability including forecasts of the CHMI and preparation of due report.*
- *Preparation of planning agenda like monthly schedule of duties being used in service providing and likewise.*



- *Elaboration of summaries about winter service providing (standby duty, winter maintenance actions, machinery at disposal...).*
- *Keeping the evidence of workers, machinery, performance, consumption of spread materials, loading sites, operation centres, maintained structures, etc.*

The “Journal of winter maintenance” is on the data and functional level connected to the “Schedule of winter maintenance” program and to the “MetIS for Windows”, WWW-MetIS respectively. Individual modules and particular targets in the system are correlated with aim of the maximal simplification of the dossier and other agenda keeping so that end users are to control the comprehensive program complex using some simple operations.

As for further JWS system development, its connection to on-board computers of modern spreaders is envisaged for instance.

### **3.3. Measuring equipment – ice warning devices of a Czech producer**

#### **3.3.1. System of visual information**

System of Road Weather Monitoring (RWM) is dedicated for corporations engaged in road winter maintenance. All the time, the system provides updated information about road surface conditions at the sites where its measuring stations are installed. It consists of network of field measuring stations that transfer the measured values to winter service dispatching workplace. The system allows for:

- *updated information obtaining from the meteorological and pavement sensors without time-out .*
- *obtaining information in real time about formation of critical state on the surveyed section*
- *monitoring of neighbouring users measuring stations and thus obtaining information about critical conditions in advance.*
- *remote controlling of warning devices and thus road users warning of emergency (dangerous conditions) in real time*
- *filing of measured data together with record of dispatcher countermeasures (adequate actions) for purpose of later assessment*
- *the RWM is only one device of this type in the CR being equipped with circuits enabling transfer and filing (storing in memory) of images made with CCD camera installed in the surveyed section. Transfer function of the image is integrated in to the system of measurement the meteorological parameters influencing road serviceability.*

As for the above described application, a standard black-and-white CCD camera 1/3" or 1/2" with higher resolution and luminous sensitivity can be used. The praxis has also proved that even a camera with high luminous sensitivity (over 0,002Lx) needs for high-quality night images at least a minimal additional lighting of monitored section.

When choosing lens, it is recommended to prefer high-quality lens with Video-Drive function of appropriate focal distance. Video signal of camera is digitised with help of RWM electronics and then it is compressed to the GIF file format. Authors of the system have verified in practice that transmission of an image can be realised even through high-quality radio links, eventually via GSM mobile phone network.

The above described original approach contributes to enhancing the capability of representation of the system and thus it allows for decreasing the number of control rides at minimum and optimising the application of chemicals.

#### **Motorway D1 Prague-Brno, 136<sup>th</sup> kilometre stone**



Shot made at 9:36 a.m.



Shot made in the same place at 7:06 p.m.

Due to topical visual information from the surveyed section, the personnel of winter service dispatching centre can in absolutely precise way assume visibility on the surveyed section, type of precipitation and its impact to the road serviceability, as well as tracking or snow-drift formation when snowing.

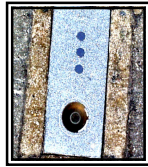
The RWM is of modular concept and enables building the network of VZH-03/M field measurement stations, which are delivered in some modifications according the requirements of users. To the VZH-03/M type station a VZH-03/S subsidiary measuring stations can be connected with cables and in case a longer distance is required, radio links are used. This concept allows for realisation of a very effectively distributed network of field measuring stations. Considerable contribution for prognosis of weather conditions development has the possibility of the neighbouring users measuring stations monitoring.

As an example of modular system application, the method of solution on the R35 expressway can be stated, where 3 VZH-03-M (Master) stations, 1 VZH-03-MV (with CCD camera) and 1 VZH-03-S (Slave) station have been installed. All the stations with exception of the slave station were connected step-by-step through channel modems to two-wire extension of total length of more than 10 km conveying to the winter maintenance long-distance control. The slave station, situated under surface of central reserve, does communicate with control station via radiomodem. With this solution, use of second communication line was enabled for meteo-stations protection and for information transmission with identification of damaged station to the police station as well as.

#### **3.3.2. Requirements in communication links**

One of the most important factors of a reliable observed section monitoring is selection of a reliable communication route in view of technical parameters and particularly in view of economical operation.

On data transmission from pavement sounds and atmospheric sensors, no special demands on data transmission rate are put. Transmission of data image file of 30Kbyte



in GIF size lasts about 1,5 minutes with transmission rate of 9,6 kbps in general use. When a user take advantage of large size image transmission possibility, where data file can be up to size 120 Kbyte, the parameter of communication route transmission rate gain an importance. Especially, where it is question of rented transmission route, it is appropriate to choice an optimal solution with regard to transmission rate, time of connection lasting and cost of communication.

As the operating costs of meteo-station network make a significant item of user financial budget, the software package of SHN-03 system allows for economical operation regime selection, if circumstances demand it. On this case, communication with winter service operation center is not periodically established in given interval but on requirement of staff with that the measured data are completed in retroactive way. Only in case, where a measuring station reach a pre-defined critical situation on the observed section, the communication is automatically made and appropriate alarm is immediately imposed.

The following transmission routes have been verified in a particular operation:

- one fixed communication link *channel /extension/ modems*
- dialed telecommunication link *extension modems, ISDN modems*
- radio network *radio modems, retransmission*
- transmission via trunk network *trunk stations*
- mobile-phone network *GSM modems*

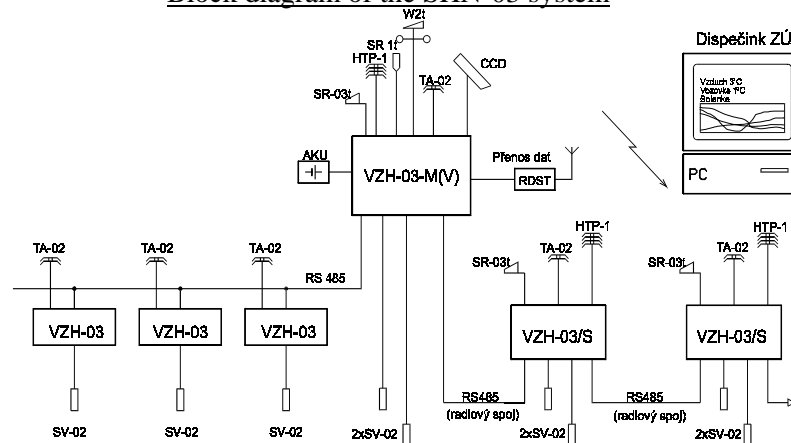
From the high transmission rates point of view, following networks are at disposal in the Czech Republic:

- mobile-phone GSM network - 9,6 to 43,2 kbps
- telecommunication network TELECOM - euro ISDN up to 64 kbps

For reaching high transmission rate, use of modems allowing an adequate high transmission rate is evidently absolutely indispensable.

### 3.3.3. Optional modules of the system

Block diagram of the SHN-03 system



VZH-03M	Processing unit on the basis of a commercial computer, control station destined for data collection, processing and sending off
VZH-03MV	Control station completed with circuits for CCD camera shooting of observed section
VZH-03S	Processing unit of the slave station
VZH-03	Station for measurement of pavement temperature and air temperature
SV-02	Pavement probe
SR-03t	Heated precipitation sensor – evaluation YES-NO
TA-02	Air temperature sensor
HTP	Air temperature sensor and relative humidity sensor – determination of dew point and hoarfrost point by calculation
SR-1t	Heated precipitation sensor of capacity
W2 t	Heated anemometer- determination of wind velocity and wind direction
CCD	CCD camera
RDST	Communication route (radio-modem, trunk station, extension- modem, mobile-phone, GSM modem)
PC	Computer of winter maintenance long-distance control equipped with control software



To the VZH-03 field measuring station in full configuration, the following sensors can be connected:

- TA-02 air temperature sensor
- HTP-1 temperature and air relative humidity sensor
- determination of dew point or hoarfrost point by calculation
- SR-03 sensor of precipitation without differentiation (rain, snow)
- heated SR1t precipitation sensor of capacity
- heated W2t anemometer (speed and direction of wind)
- two SV-02 probes in the pavement
- CCD camera

With the VZH-03 minimal configuration, a measuring station with TA-02, SR-03 and SV-02 sensors will be sufficient.

### 3.3.4. Requirements for HW and SW supply for users



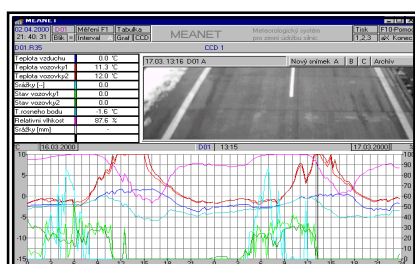
Basic outfit of winter service dispatching centre consists of a device for data transmission from measuring stations along with Pentium personal computer working in the WINDOWS 95/98 or WINDOWS NT operating systems. Collection, displaying, evaluation and data storing are the MEANET software of SHN-02 system aided. For realisation of less costing subsidiary management workplaces at operation centres, a version of software for DOS operating system suitable for PC 386 computer category is at disposal.

### 3.3.5. Scope of presentation

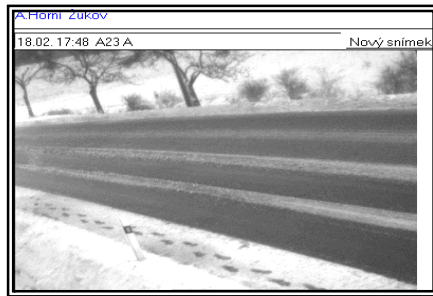
Topical data from the measuring stations are displayed in tabular and graphical form. There are presented the following data in the table by full outfit of measuring station:

- temperature and air temperature course in range from  $-40$  to  $+50^{\circ}\text{C}$  with distinction of  $0,1^{\circ}\text{C}$
- relative air humidity in range from 0 to 100% of relative humidity
- value of hoarfrost point, dew point from  $-50$  to  $+50^{\circ}\text{C}$  dew point respectively
- precipitation yes/no
- precipitation rate with division by 0,2 mm
- speed of wind in range of 0,8 to 30m/s
- direction of wind with textual expression for sixteen directions of wind rose
- road surface temperature and its course (trend) (for two probes) in range from  $-40$  to  $+50^{\circ}\text{C}$ , with distinction of  $0,1^{\circ}\text{C}$
- road surface conditions (dry, wet, moist, brine, accident danger, black ice)
- position of hazard warning light (on/off)
- interval of data updating
- state of fail-safe contacts, other information by user request

The hazardous conditions, which cause the road serviceability worsening, are evaluated in automatic way and signalled on the display, eventually with acoustic signal. Dispatching staff can immediately warn the users of surveyed section with remote switching of warning panels or lights on. Alarms and their acceptance by



controller are stored in the computer. Visual information on the surveyed section is a very important feature of the system namely in time of heavy snowfall. Detailed information on road weather conditions development is afforded with graphical record of the data measured on the station in question. These records are stored in permanent way for further evaluation.



The most important contribution of the system (namely at heavy snowfall) is clearly the possibility to obtain a prompt visual information from the surveyed section. The possibility of the real time situation on the road assessment in connection with data measurement analysis and the possibility of supplementary visual information about road surface condition bring to road managers an

enlargement of documents needed for final correct and effective decision making in selection of kind of activity of subsequent necessary winter service performance.

### **3.3.6. Complying with operating conditions**

Software of a long-distance center is devised on the basis of many years' experiences resulting from practical tests of equipment and requirements of users. There are 46 field measuring stations of RWM system yet in operation in the Czech Republic. The VZH-03 evaluating device has been certified including its modifications according to relevant regulations. In the winter period of 1998/99, the RWM system has been successfully verified within the DRM pilot project on the "Measurement of parameters influencing road serviceability due to weather changes." On the strength of this document, the Ministry of Transportation and Communications of the Czech Republic issued in collaboration with the DRM and the CHMI an "Approval " about complying with the claims for this technology to be applied on the Czech Republic road and motorway network.

## **4. Conclusions about winter service in the Czech Republic**

This days, due attention is paid to the problems of road winter maintenance even from the view of the Czech Republic authorities. This is resulting in essence from logical analysis of factual impact of winter service upon the national economy .It could be mentioned in this occasion that the costs for winter service on the Czech Republic road network have "consumed " in recent years about 30% in average each year of the total financial subvention provided for year-round activities of our road administrators. That is just way it is indispensable to promote the used methods and forms. Nevertheless, a correct and reliable co-ordination of all specific phenomena in the sphere of management and execution is needed. We can state with pleasure that the strategy of winter service performance in the Czech Republic is gradually adapted to the standardisation applied in the European Union and other advanced countries. Last eight years, we are witness of permanent enhancement of winter service effectiveness on our roads and motorways. This positive trend is predominantly conditional on the technical progress and also on consistent change in view of advanced technologies specific applications. Different measures, which deeply influence road serviceability ensuring and, in particular, create a scope for the most suitable and effective method of winter maintenance management, are well know these days by all our road administrators, and frequently fully applied in practice:

- *Continuous enhancement of spreading devices*
- *implementation of electronic controlled operating elements*
- *Development and practical use of technologies for wet salt application*
- *Purchase of only high-quality spreading salts of standard*
- *Appropriate storage of chemicals (extension of use of vertical all-wood silos for salt storing)*
- *Consistent training of winter service staff, namely in the sphere of operating conditions for road spreading keeping up as well as various related legal prescriptions.*
- *Larger and consistent use of various auxiliary means (road weather forecasts, thermal mapping, ice warning devices) by managers in decision making, etc.*

## **BASIC FACTS OF THE CZECH REPUBLIC**



### ***POPULATION***

The Czech Republic is situated on an area of 78 866 km<sup>2</sup> and has a population of 10.3 million people, 5 million males and 5.3 million females. Three quarters of the population live in urban areas.

The population density is 131 inhabitants per sq. km, the total growth in population in the Czech Republic being 0.8 persons per 1,000 inhabitants.

### ***CLIMATE***

The Czech Republic lies in the temperate climate zone of Central Europe, which makes for pleasantly mild summers and winters with only moderate amounts of precipitation. Winter climate conditions are predominantly caused by black ice development, either by hard packing of snow-layers or freezing moisture at frequent temperature fluctuations near freezing point in relative high air humidity. High-intensity snow precipitation doesn't have much influence on heavy snowfall development and occurs in higher locations only.

Lowland temperatures in July average 20 °C, and in mountainous areas 8°-11 °C.

Lowland temperatures in January average -1° to -2 °C, -5° to -7 °C in the mountains.

### ***TOPOGRAPHY***

The divide between the two principal mountain systems in Europe - the Hercynian and Alpine-Himalayan - runs through Czech territory. The country's topography is therefore quite varied: plains (4.5% of the country), hills (50.1%), highlands (33.9%) and mountains (11.6%). Altitude levels: lowland regions under 200 m above sea level make up 4.95% of the country, regions 200 - 500 m above sea level make up 74.1%, regions 600 - 1,000 m above sea level 19.3% and regions over 1,000 m above sea level 1.6%.

### ***ROAD NETWORK AND TRAFFIC DATA***

The present road network in operation on territory of the Czech Republic consists of 515 km the final planned total length of motorways is about 1 001 km - of motorways and of 54 895 km of all-purpose roads, of which 5 993 km of Class I, 14 660 km of Class II and 34 242 km of Class III roads. Motorways and major all-purpose roads, carrying the prevailing part of traffic volumes, connect principal administration and economic centres of the country as well as its resort areas. They encompass the network of 2 644 km of international „E“ roads (including motorways), set down by the European Agreement AGR. With its density of road and motorway network of 0,70 km per 1 km<sup>2</sup> of area, the Czech Republic ranks among the prominent European countries in this respect.

449 vehicles, of which 358 passenger cars, came to 1 000 inhabitants. The last national traffic census in 1995 (an other traffic census has been realised in 2000, however, the results are not up to time of this paper elaboration placed at disposal) has ascertained average traffic volumes on all-purpose roads and motorways as well as total traffic performance, which amounted to 34,7 milliards vehicles per km p.a. in 1995, representing a growth to 228 % of the 1970 value, while the increase between the 1990 and 1995 national traffic censuses was 21 %. Another increase of traffic performance growth between 1995 and 2000 is estimated to 28%.