WINTER SEASON 2017 / 2018 SELECTED WEATHER FACTS ON THE EXAMPLE OF A FIXED AUTOMATED SPRAYING SYSTEM IN PILISVÖRÖSVÁR (HUNGARY)

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The climate of the Hungary can be described as typical European continental influenced climate with warm, dry summers and fairly cold winters. January is the coldest month with daytime temperatures usually around zero, but in some cases winter months can be very cold with temperatures far below zero and strong, cold north-easterly winds. Heavy snowfall or even snowstorms are also possible on some days there; the yearly average number of days with snow is less than 40 in the low-land regions of Hungary [1].

Minus temperatures, snowfalls and slipperiness of roadway are always a problem for citizens and drivers. There are specific places where, this not often winner conditions, can cause long distance traffic congestions. On of such place is tunnel under rail line in Pilisvörösvár, city placed c.a. 9 km from borders of Budapest. This ex main road to Vienna is important communication duct, also for heavy traffic. Mostly road was built as a flat without very steep inclines. But because of need of reconstruction of rail line and need of elimination railroad crossing with a barrier, small tunnel under railroad was constructed. In down part of the tunnel intersection with road lights was planned. This technical solution on one hand solved traffic problems but on other hand caused new environmental interaction between road and weather. Winter conditions on slopes became important problem for braking drivers approaching tunnel and for heavy vehicles trying to move from interchange with traffic lights.

In 2017 Boschung Mecatronic AG Fixed Automated Spray System was installed in this tunnel. Micro FAST solution, based on high pressure fine-spray installation of longitudinal profiles (pressure tubes), has built-in nozzles every 5 meters. The nozzles are fixed by means of a sealing compound in the upper layer of technical sidewalks on both sides of the road. A working pressure of 16 bars and spray duration of 40 seconds ensure the proper coverage of the surface with the equivalent of 2 grams of salt per square meter. The nozzles are equipped with two micro fine-spray holes, which dispense the thawing agent onto the road surface almost invisibly, thanks to the high degree of pulverisation. The thawing agent is then equally distributed on the carriageway surface by the traffic [2].

Pump station was placed in the chamber next to the tunnel, as well as 8 000 l calcium chloride brine tanks, 3 000 l water tanks and weather station. Installation in Pilisvörösvár was planned as c.a. 200 m long, with total 100 Micro-fast nozzles placed on both sides of the road.

Weather station has its most important role for such a system and it was equipped with two active pavement sensors (type BOSO and type ARCTIS) and with thermo-hygrometer and precipitation sensor. Role of this station is to measure air parameters, presence of precipitation and its type and road condition. Most important for successful work of the system, is active measurement of the freezing point temperature (by mean of cooling and heating) as well as constant monitoring of moisture and temperature of the roadway. Thanks to measured

data, automatic ice early warning alarms are computed in weather station to trigger spraying process. Management software stores measured data, alarms as well information about spraying in the past. Thanks to this after winter analyses of all data is available.

Description	value	unit
The air temperature has reached or dropped below 0°C	95	times
The pavement temperature has reached or dropped below 0°C	91	times
The freezing point temperature reached or dropped below pavement temperature when road was wet	45	times
Days when weather station reported weather alarms (different types)	90	days
Days with presence of precipitation (different types and durations)	55	days
Days with presence of snow precipitation	29	days
Key days of most often alarming and spraying	38	days
Brine used in total (calculated from % of tanks)	9120	liters
Spray programs triggered in total	298	times
Spray programs triggered because of weather conditions	251	times
Spray programs triggered for self-cleaning (maintenance spraying)	47	times
The average amount of liquid used for one spray (calculated from % of tanks and number of spray programs)	30,60	liters
Average time of spraying for one nozzle	40	seconds
Number of nozzles	100	pieces
Average quantity of de-icer sprayed by one nozzle	306	ml

Fig. 1. Selected weather and spraying system facts

Author would like to share with readers some facts and statistics from first operational winter of the system (**Fig. 1**). Crucial for road conditions are so called "zero crossings", when pavement or air temperature goes below 0°C. On other hand from point of view of road maintenance real problems starts when temperature of road goes below freezing point temperature of the liquid on the surface of the road. For statistics there was chosen period from first day when air or pavement temperature reached 0°C (31.10.2017) till last such phenomenon this winter (28.03.2018). Thus all below presented statistics are given for period of 148 days.

Official commissioning of the system took place on 29.11.2018, when the first truly winter conditions appeared in Pilisvörösvár, including air temperatures below 0°C and first snow. Of course winter conditions (minus temperatures) were present also before that date but they were not dangerous for road users and they didn't triggered spraying.

First time freezing point temperature was measured by mean of active way on 30.10.2017 and last time on 18.03.2018. What needs to be underlined, freezing point temperature from Arctis active sensor is measured according to standard EN 15518-3. According to this sensor starts measuring cycles when tow conditions are met: pavement must be moist with film thickness 0,05-0,5 mm and must be started from ≤ 4 °C of pavement surface temperature. Thanks to this, measurement is independent of the de-icing agent being used and accuracy of 0,5°C is kept [3].

This statistics can be analysed in various ways, but it must be underlined that system installed in Pilisvörösvár is truly answering to specific winter road conditions of this particular place and supports road flow and safety.

Dedicated to all those people who were involved in successful completion of this project, especially to Bapst Jonathan, Kruger Thomas, Lourenço Filipe, Mayerhofer Erich, Pammer Michael, Pásztor Zoltán, Szczerbinski András, Szczerbiński Jaś, Szczerbiński Marcin and many others.

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3. EN 15518-3 Winter maintenance equipment - Road weather information systems - Part 3: Requirements on measured values of stationary equipment, **2011**.