

WINTER SERVICE ON THE BRIDGES ON A2 MOTORWAY IN CROATIA AS A PART OF SUSTAINABLE DEVELOPMENT

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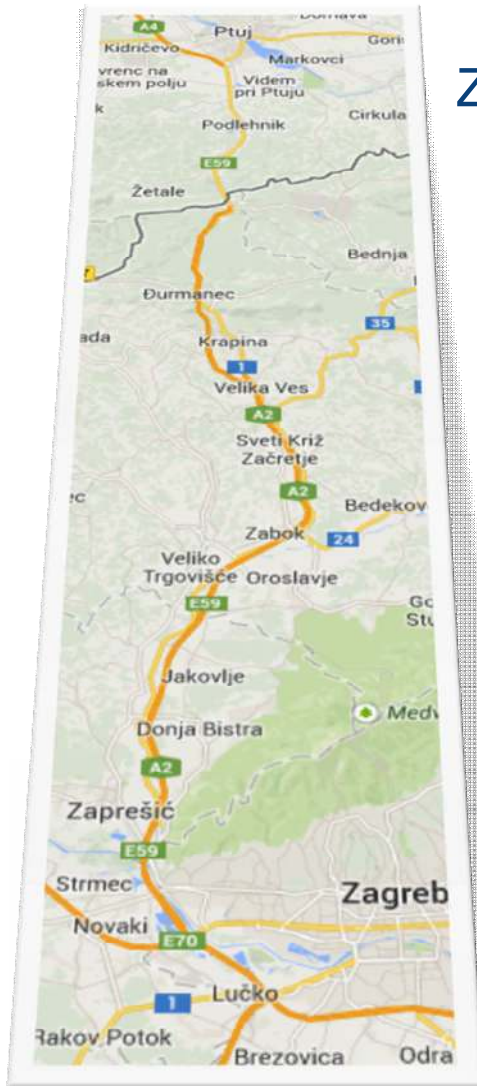
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1. INTRODUCTION

Zagreb – Macelj Motorway - 60 km - connection between central and SE Europe





Zagreb – Macelj motorway is a part of the Pyhrn road route.

Marked A2 in Croatia and E-59 in Europe.

The total length of the motorway is 60 km

Mountainous section with length of 17, 9 km

9 viaducts and 6 tunnels

5 viaducts connected with tunnels = possible problems in winter service !

Dangerous 5 !



2. CONCEPT

TODAY – during preventive maintenance all bridges treated equally – with maximum quantity of salt

IDEA – different treatment – according to risk

METHOD – calculation of safety coefficient for each viaduct and classification into groups

DATA - manually measured temperatures in each of the 9 patrols within 24 hours and on 8 locations for 4 years (around 3600 measurements in total)

GOAL – reduction of the salt consumption with the same level of service

2. METHODOLOGY

1. Calculation of average temperatures, percentage of measurements with wind and wet carriageway

	TOTAL (2009-2012)	
V.KRAPINČICA		
TEMPERATURE	1,18	av. from 3570 measurements
WET SURFACE	61,65%	2170/ 3520
WIND PRESENCE	25,29%	891/ 3523
V.ŠUM		
TEMPERATURE	1,2	av. from 3500 measurements
WET SURFACE	61,79%	2167/ 3507
WIND PRESENCE	22,95%	805/ 3508
V.PUHI		
TEMPERATURE	0,86	av. from 3578 measurements
WET SURFACE	63,17%	2249/ 3560
WIND PRESENCE	26,54%	944/ 3557
V.MIMARJE		
TEMPERATURE	0,75	av. from 3506 measurements
WET SURFACE	64,84%	2278/ 3513
WIND PRESENCE	25,65%	902/ 3517
V.GORNJ MACELJ		
TEMPERATURE	0,27	av. from 3593 measurements
WET SURFACE	65,89%	2368/ 3594
WIND PRESENCE	24,94%	899/ 3604
AVERAGE AIR TEMPERATURE	-0,31	av. from 3505 measurements

2. Calculation of safety coefficient - k

$k = k_0 - k_1 - k_2$					
k	safety coefficient				
k0	coefficient - difference to air temperature				
k1	coefficient - difference to average wet road percentage				
k2	coefficient - difference to average wind percentage				
	Krapinčica	Sum	Puhi	Mimarje	Gornji Macelj
TEMP	1,18	1,2	0,86	0,75	0,27
AIR TEMP.	-0,31				
Difference to air temp.	1,49	1,51	1,17	1,06	0,58
k0	1,49	1,51	1,17	1,06	0,58
Wet road percentage	61,65%	61,79%	63,17%	64,84%	65,89%
Average	63,47%				
Difference to average	-1,82%	-1,68%	-0,30%	1,37%	2,42%
k1	-0,018	-0,17	-0,003	0,014	0,24
Wind percentage	25,29%	22,95%	26,54%	25,65%	24,94%
Average	25,07%				
Difference to average	0,22%	-2,12%	1,47%	0,58%	-0,13%
k2	0,002	-0,021	0,015	0,006	-0,013
k	1,506	1,548	1,158	1,04	0,569

3. Criteria for grouping, grouping and usage of spreading materials in relation with groups

	k		Risk level
	from	till	Classification
G	1,601	...	normal
G1	1,201	1,600	risky
G2	0,601	1,200	very risky
G3	0,000	0,600	dangerous

Viaduct	k	GROUP 1,2,3
Krapinčica	1,506	G1
Šum	1,548	G1
Puhi	1,158	G2
Mimarje	1,040	G2
Gornji Macelj	0,569	G3

G	G1 (G+10)	G2 (G+20) (max.40)	G3 (G+30) (max.40)
10	20	30	40
20	30	40	40
30	40	40	40

3. CONCLUSION

Thanks to the method that is presented in this paper, savings in the consumption of salt will be achieved.

After the coefficient k is calculated 5 viaducts are classified into groups G1, G2, G3.

Other 4 viaducts can be classified according to the work results:

Viaduct	k	GROUP
Krapinčica	1,506	G1
Jurički		G1
Tkalci		G1
Šum	1,548	G1
Puhi	1,158	G2
Ravninščica		G2
Straža		G2
Mimarje	1,04	G2
Gornji Macelj	0,569	G3

If the rest of the motorway is treated with $10\text{g}/\text{m}^2$,

4 viaducts with $20\text{ g}/\text{m}^2$ (group G1),

4 viaducts with $30\text{ g}/\text{m}^2$ (group G2),

1 viaduct with $40\text{ g}/\text{m}^2$ (group G3).

**THE NEW WAY OF WORKING WILL ENSURE 12,3%
SAVINGS OF SALT, COMPARED WITH AN OLD WAY!**