

SIRWEC 2012 Paper 0068 "New findings in winter maintenance and their implementation in Austria"



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1 Facts – Winter maintenance, salt usage & environment in Austria

- Winter maintenance as a part of road maintenance defines the accessibility during the winter period and is therefore of high importance for the people and the economy in Austria.
 Conclusion: Winter maintenance is important
- Winter maintenance from 1st of Nov. to 31st of March is responsible for approximately 20% of maintenance costs on regional roads; respectively 25% to 30% on highways in Austria.
 Conclusion: Winter maintenance costs a lot of money
- Road authorities are pressurized by public opinion and existing legislation to provide high road safety standards at all times – but have very limited resources.
 Conclusion: Need for optimized winter maintenance standards for all levels of roads
- The ministry of transport, the highway operator (ASFINAG) and the regional governments of Austria pooled funds for the research of winter maintenance with special emphasis on salting. Conclusion: The guys a the University are cheap – let's see what they can do



2 Modelling - Salt usage and cost comparison





3 Freezing point of sodium and calcium chloride brines

Freezing point

- Thawing if concentration of snow and salt has a lower freezing point as the road
- Cost efficient and mainly used de-icing agent is sodium chloride (NaCl)







4 Residual salt due to discharge losses, traffic and surface condition

Residual salt – FS30

- Results show initial salt losses of around 60%
- Further losses related to traffic & surface conditions





Traffic volume after treatment [pc]



5 Limited de-icing capability of sodium chloride

Freezing point

- Theoretical thawing capacity is very limited
- Salt losses reduce practical thawing capacity
- Results show initial salt losses of around 60%
- Further losses related to traffic & surface conditions





6 Importance of a preventive treatment

Preventive

- If physical thawing capacity is exceeded snow on the road is unavoidable.
- To form a release coating an application of 10 g/m² is usually sufficient.
- The release coating is to be renewed with each treatment during snowfall
- After snowfall the remaining snow may be removed with ploughing and salting

Physical mechanism "Preventive treatment"								
	1. Preventive treatment just before snowfall event							
2000	e.g. 10 g/m ² immediately prior to snowfall of about 1 cm/h Road surface temperature = - 5°C Treatment interval = 3 h 3 cm snow height during interval							
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	 Phase snow/ice (about 0% salt) Phase brine below (8% salt) The applied salt is dissolved gradually, until an equilibrium concentration is reached at 8% and -5°C 							
	3. Snowploughing and salting							
	The brine prevents adhesion of the snow on the road surface and relieves further snowploughing. For salt application applies: remaining snow + applied salt = brine > 8% (Salt consumption depends on quality of ploughing and road condition)							
	4. Thaw residual snow (continue with 2)							
	Thaw of the remaining snow and brine formation > 8%; ongoing development according to 2 until end of snowfalls (discharge loss due to traffic and mixing not considered)							



7 Possible problems with delayed treatment

Delayed

- Snow is already compressed on the road surface
- Quality of ploughing in this cases is sufficiently lower
- Thawing attempts in such cases will create a slippery brine film on the snow layer

Physical me	chanism "Delayed treatment"
	1. Snowfall and ice formation
	Snowfall of 1cm/h adds up to 3cm during the interval which are discharged or compressed by traffic.
	Possibility of ice formation due to high pressure or freezing of snow to the road surface
	2. Snowploughing and salting
	Increased Ploughing energy needed due to absence of release coating, higher remaining snow volume= higher salt rates needed
MARCA	Residual snow + salt = brine > 8% (Salt consumption depends on quality of ploughing and road condition)
\\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\	3. Icy conditions during melting process (2 phases)
	 Phase brine on top (>8% salt) Phase snow/ice (about 0% salt)
LAR	During the melting process >15 - 30 minutes vehicles drive on a layer of ice
	4. (Partial) Thawing of remaining snow
	With adequate ploughing and salting remaining snow thaw under formation of brine > 8% concentration Otherwise further development as in point 2 of the preventive treatment. With insufficient salting threatens icy conditions



8 Application rates due to precipitation, temperature and traffic

Precipitation 0,0 mm to 0,25 mm - Snow hight 0,0 cm to 0,25 cm										Precipitation 0,25 mm to 0,5 mm - Snow hight 0,25 cm to 0,5 cm													
Hoarfrost or slightly visible snowfall												Very light snowfall											
Ap	plication	Road surface temperature [°C]											Application Road surface temperature [°C]										
ra	ite [g/m ²]	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10		rate [g/m ²]	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
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7 Road safety - Driving and treatment recommendations

1/2

Picture documentary	Road condition	Treatment recommendation	Treatment recommendation		
	Dry road:	Minimal salting only at hoarfrost:	Minimal salting only at hoarfrost:		
	No sleekness expected Surfact temperature: -30°C to +60°C High skid resistance, $\mu = 0,6 - 1,0$	No treatment required	No restrictions due to weather based road conditions needed.		
	Hoarfrost possible or expected (usually at 2 - 4 am)	Preventive treatment 5 – 10* g/m ² with beginning hoarfrost	Reduction of the speed by at exposed road sections (e.g. bridges)		
	Moist or wet road:	Salting at temperatures below 0°C:	Local ice at sub-zero temperatures:		
-	Road surface temperature > 0° C Moderate skid resistance, μ = 0,4 – 0,7	No treatment required (Watch temperature!)	Reduction of speed in case of lane grooves		
	Road surface temperature $\leq 0^{\circ}$ C Moist road Moderate skid resistance, $\mu = 0, 2 - 0, 6$	Preventive treatment with 5 – 10* g/m ² Before beginning freezing	Caution, black ice possible, Reduction of the speed by 50% at exposed road sections		
	Road surface temperature $\leq 0^{\circ}$ C Wet road Very low skid resistance, $\mu = 0, 1 - 0, 6$	Treatment with 20 to 40* g/m ² before freezing critical Warning messages if black ice forms!	Caution, black ice possible, Reduction of the speed by 70% at exposed road sections		
	Snow next to wheel tracks:	Ploughing and salting:	Adapted driving:		
	No snowfall Wheel tracks free of snow Moderate skid resistance, $\mu = 0.3 - 0.5$	Ploughing and salting with 10 – 20* g/m², to remove remaining snow	Adapted driving.		
	Snowfall less than 0,5 cm/interval Low skid resistance, $\mu = 0,2 - 0,4$	Ploughing and salting with 10 – 20* g/m²			
	Snowfall more than 0,5 cm/interval Snow in wheel tracks Low skid resistance, $\mu = 0,2 - 0,4$	Ploughing and salting 10 g/m ² (release coating!) until end of snowfalls, then ploughing and salting with 10 – 20* g/m ²	Adapted driving to road conditions. Reduction of the speed by 30 to 40% Consider restricted visibility!		



7 Road safety - Driving and treatment recommendations

2/2

Picture documentary	Road condition	Treatment recommendation	Treatment recommendation
	Snow in wheel tracks:	Ploughing and salting:	Adapted driving::
	No snowfall Road covered with snow Low skid resistance, μ = 0,2 – 0,3	Ploughing and salting with 20 – 30* g/m², to remove remaining snow	Adapted driving. Reduction of the speed by 40 to 50%
	Snowfall less than 0,5 cm/interval Low skid resistance, $\mu = 0,2 - 0,3$	Ploughing and salting with 10 – 20* g/m²	
	Snowfall more than 0,5 cm/interval Very low skid resistance, $\mu = 0, 1 - 0, 3$	Ploughing and salting 10 g/m^2 (release coating!) until end of snowfalls, then ploughing and salting with $20 - 30^* g/m^2$	Adapted driving to road conditions. Reduction of the speed by 60 to 70% Consider restricted visibility!
	Very low skid resistance	Salting as required:	Particular caution, walking pace:
	No precipitation Road surface temperature $\leq 0^{\circ}$ C. Very low skid resistance, $\mu = 0,05 - 0,2$	Preventive treatment if possible, Maximum treatment at critical/icy Spots, Further treatments as necessary	Follow driving restriction until clearance of road. Pass dangerous areas with walking pace
	Black ice and further precipitation (Snow or rain) Very low skid resistance, $\mu = 0.05 - 0.2$	Maximum treatment until ice is cleared Closure of road sections as necessary. Opening after closure only if skid resistance is sufficient	Caution, ice beneath snow layer is not visible and therefore dangerous. Adapted driving to road conditions. Reduction of the speed to walking pace

Dry and wet roads are usually safe – the developed model allows an optimization of winter maintenance in real time – but responsible driving is still necessary !!!

THANK YOU FOR YOUR ATTENTION