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SURF 2012

CORRELATION BETWEEN ROAD PAVEMENT SKID RESISTANCE AND BRAKING DECELERATION

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Background

- Regular monitoring of skid resistance

– Are the results ready for public use?

– Are they ready to be used in legal processes?

- Posting traffic signs (speed limits, slippery road, …)

– When are they needed?

Assessment criteria

- **Technical specs for roads, SRA internal**
- **Are these understood correctly?**
- **Can we relate them to traffic safety?**

Speed of measurements (km/h)	Condition: Very poor	Poor	Fair	Good	Very good
30	< 50	50 – 56	57 – 61	62 – 72	> 72
40	< 46	46 – 52	53 – 56	57 – 67	> 67
50	< 42	42 – 48	49 – 52	53 – 63	> 63
60	< 39	39 – 45	46 – 48	49 – 59	> 59
70	< 36	36 – 42	43 – 45	46 – 56	> 56
80	< 33	33 – 39	40 – 42	43 – 53	> 53
90	< 30	30 – 36	37 – 39	40 – 50	> 50
		LIMIT	WARNING	ACCEPTANCE	

Slovenian Roads Agency

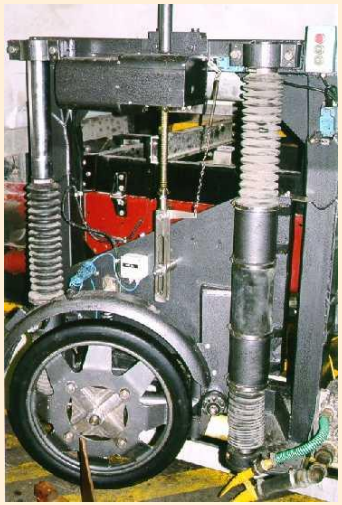
- Monitoring and criteria for pavement management
- Road network condition, prioritization of road sections for maintenance and planning maintenance works
- Misunderstandings and wrong uses
- Research to relate skid resistance data and stopping sight distance

Test setup

- **SCRIMTEX – SFC**
- **Full braking – normalized braking deceleration**

Devices

- **SCRIMTEX**



Devices

- Assembly for measuring braking deceleration
- Compact car, family minivan
- Used and new winter tyres, used and new summer tyres



Surfaces

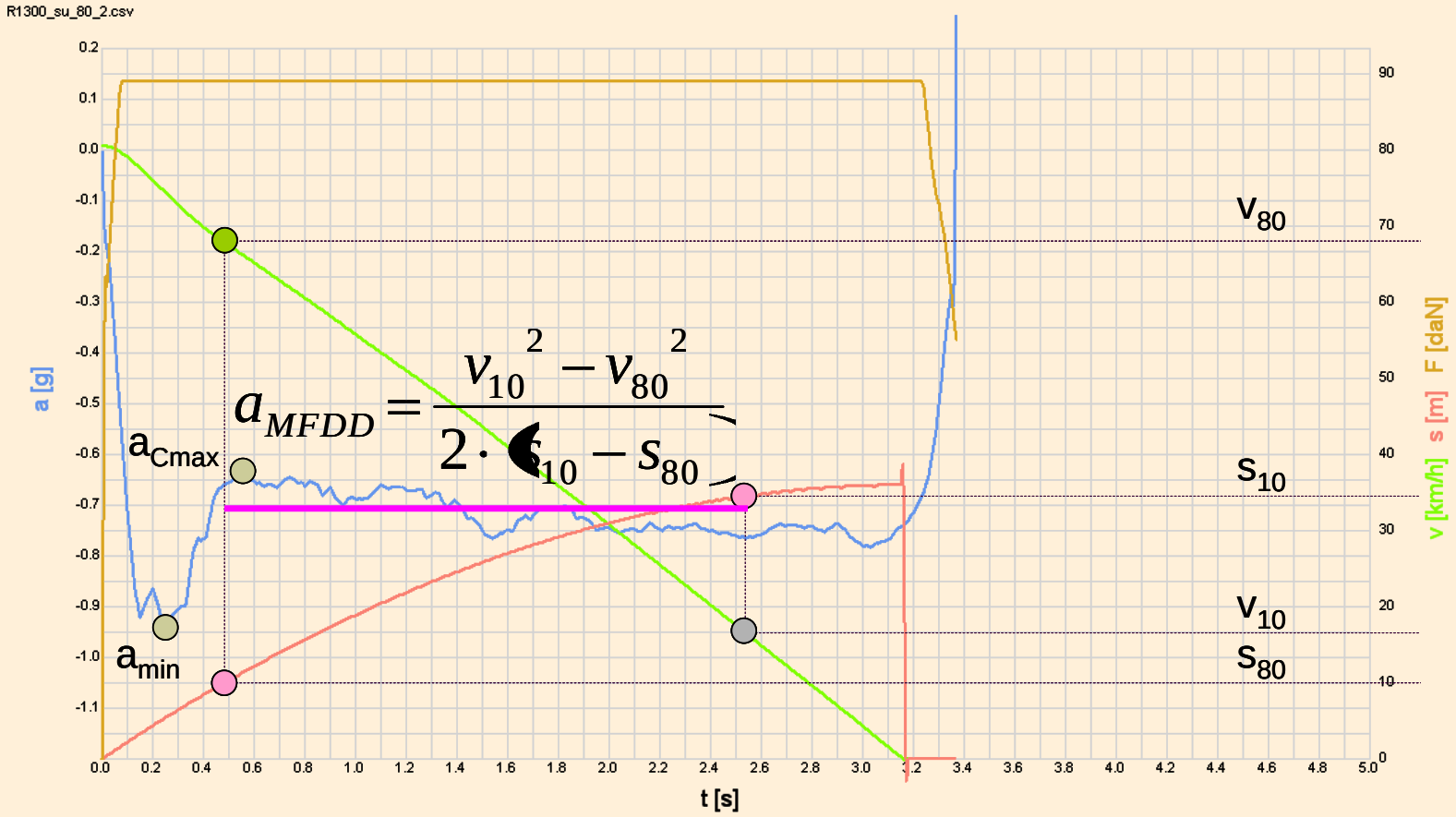
- **100m long straight stretches on national roads**

MSI distress	SR	AC 11 surf B 50/70 A2	AC 11 surf B 50/70 A3	AC 8 surf B 50/70 A3	AC 8 surf B 70/100 A4	SD 4/8
good	good	■			■	■
	fair		■			
	poor	■	■	■	■	
fair	good					
	fair		■			
	poor		■	■		
poor	good		■	■		
	fair		■			
	poor			■		

Surfaces

- **Skid resistance: 50km/h, 60km/h, 80km/h**
- **Braking: 40km/h, 60km/h, 80km/h**
- **Braking on dry and wet surface**

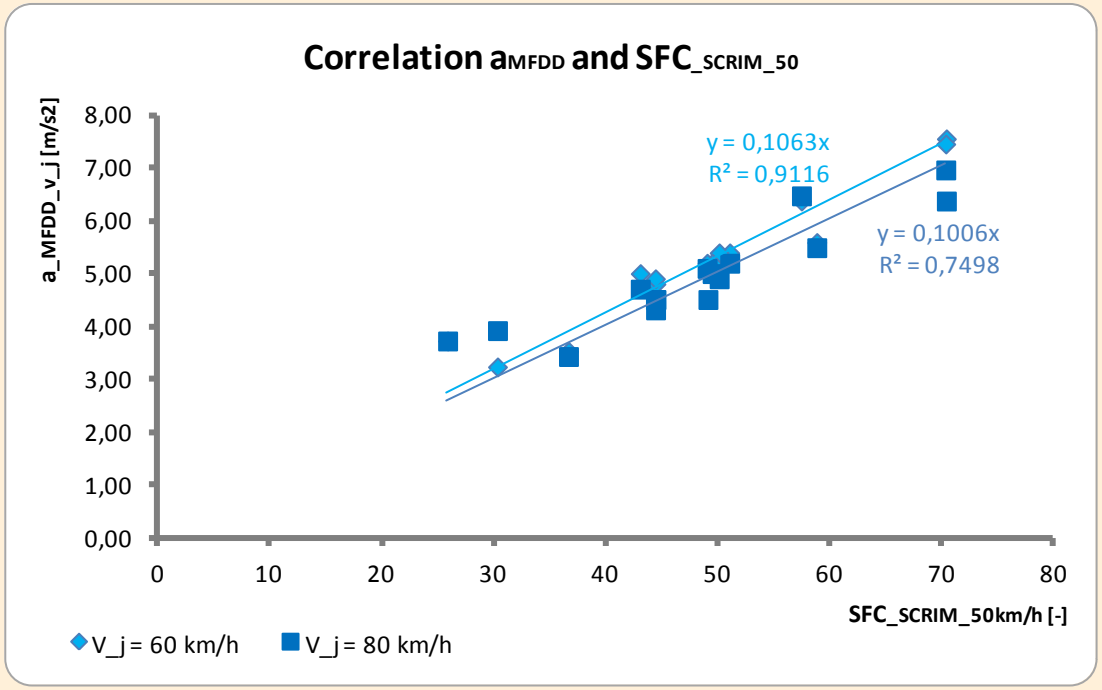
Braking deceleration



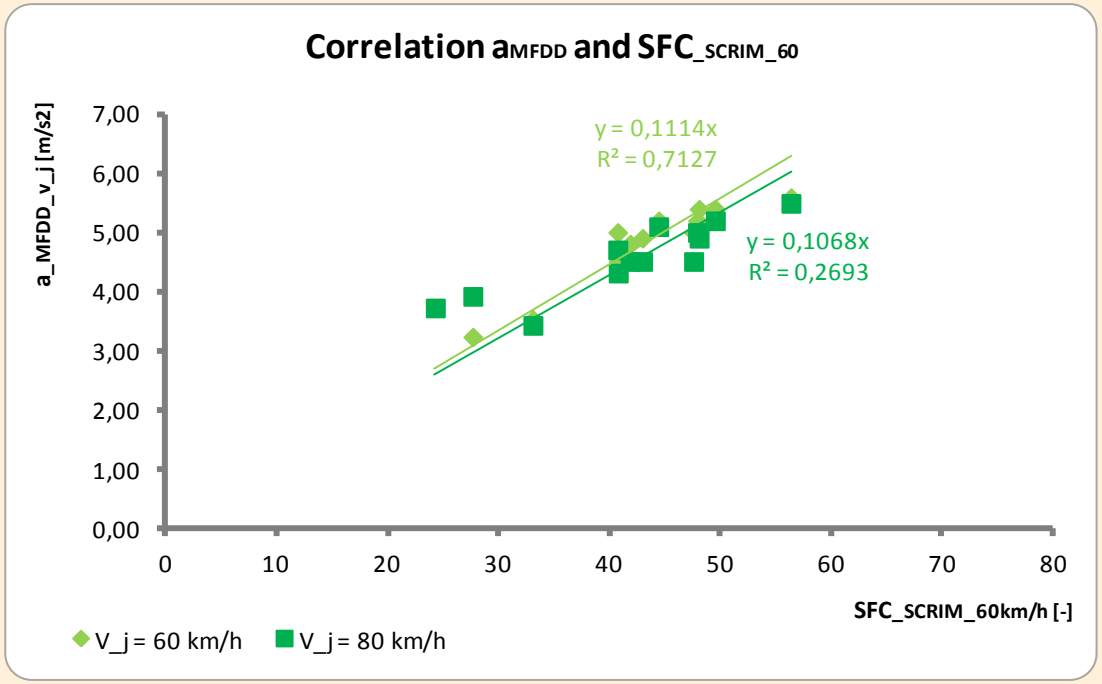
Results

- **Hypothesis 1: low SR – low deceleration** ✓
- **Hypothesis 2: SR known – can we relate it to a_{MFDD}?** ✓ ✗
- **Correlations defined for a specific vehicle system (without ABS) on a wet road surface**

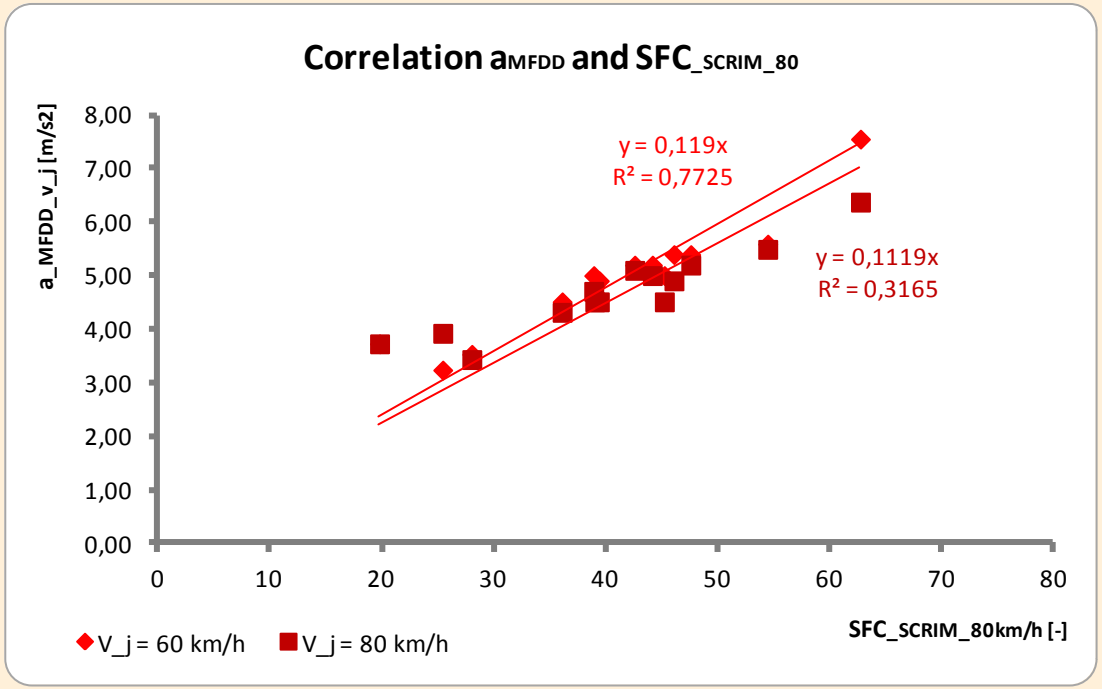
Results


Correlation aMFDD and SFC_SCRIM_50
a_MFDD_v_j [m/s2]
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0
10
20
30
40
50
60
70
80
SFC_SCRIM_50km/h [-]
y = 0,1063x
R² = 0,9116
y = 0,1006x
R² = 0,7498
V_j = 60 km/h
V_j = 80 km/h

Results


Correlation aMFDD and SFC_SCRIM_60
a_MFDD_v_j [m/s2]
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0
10
20
30
40
50
60
70
80
SFC_SCRIM_60km/h [-]
y = 0,1114x
R² = 0,7127
y = 0,1068x
R² = 0,2693
V_j = 60 km/h
V_j = 80 km/h

Results


Correlation aMFDD and SFC_SCRIM_80
a_MFDD_v_j [m/s2]
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0
10
20
30
40
50
60
70
80
y = 0,119x
R² = 0,7725
y = 0,1119x
R² = 0,3165
V_j = 60 km/h
V_j = 80 km/h
SFC_SCRIM_80km/h [-]

Results - further use

	$a_{\_MFDD\_60}$	$a_{\_MFDD\_80}$
SCRIM_50	✓	✓
SCRIM_60	✓	✗
SCRIM_80	✓	✗

- **Relating skid resistance to deceleration: β_{xy} is depending on the SFC and MFDD measuring speeds**

$$a_{\_MFDD\_j} = \beta_{xy}\, SR_{\_SCRIM\_i}$$

$$L_2 = \frac{v_j^2}{2 \cdot \left(a_{MFDD\_j} + \frac{s}{100} \right) \cdot g}$$

Results - further use

- **Minimal stopping distance values that satisfy road design regulation**

$$L_2 = \frac{1}{3{,}6^2 \cdot g} \cdot \int_{V_1}^{V_2} \frac{v}{f_{T\_dop}(v) + \frac{s}{100} + u(v)}\, dv$$

$$f_{T\_dop} = \mu_g = 0{,}2 \cdot \left(\frac{V}{100}\right)^2 - 0{,}629 \cdot \left(\frac{V}{100}\right) + 0{,}637$$

$$u = 0{,}461 \cdot 10^{-4} \left(\frac{V}{3{,}6}\right)^2$$

SPEED V_{85}

SCRIM MIN VALUES

[km/h]	SR_sc… [-]		
	f_var=1,0		
	v_sc_i [km/h]		
	50	60	80
40	44	42	39
50	41	39	37
60	39	37	35
70	37	35	33
80	36	34	32
90	35	33	31

SCRIM SPEED

- **Minimal stopping distance values + relationship determined = minimum skid resistance levels**

Results - further use

- **By introducing partial factors - new stopping distances calculated - characteristic skid resistance threshold values**

MIN WARNING ACCEPTANCE

Hitrost * v_j [km/h]	SR_SCRIM_i pogojno [-]			SR_SCRIM_i mejno [-]			SR_SCRIM_i prevzemno [-]		
	f_var=1,0			f_var=0,85			f_var=0,75		
	v_sc_i [km/h]			v_sc_i [km/h]			v_sc_i [km/h]		
	50	60	80	50	60	80	50	60	80
40	44	42	39	52	49	46	58	55	53
50	41	39	37	49	46	43	55	52	49
60	39	37	35	46	44	41	52	49	47
70	37	35	33	44	42	40	50	47	45
80	36	34	32	42	40	38	48	45	43
90	35	33	31	40	39	37	46	43	41

Conclusions

- Need for relating skid resistance data to safe vehicle stopping
- Seeking for correlation SCRIM SFC and achievable deceleration (mean fully developed decelerations) by means of full braking tests in different driving conditions
- Correlations defined for a specific vehicle system (no ABS) on a wet road surface
- Minimum requested SR levels calculated

Thank you for your attention!

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