



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA INFRASTRUKTURO IN ENERGETIKO
DIREKCIJA REPUBLIKE SLOVENIJE ZA INFRASTRUKTURO
Sektor za vzdrževanje, varstvo cest in prometno varnost



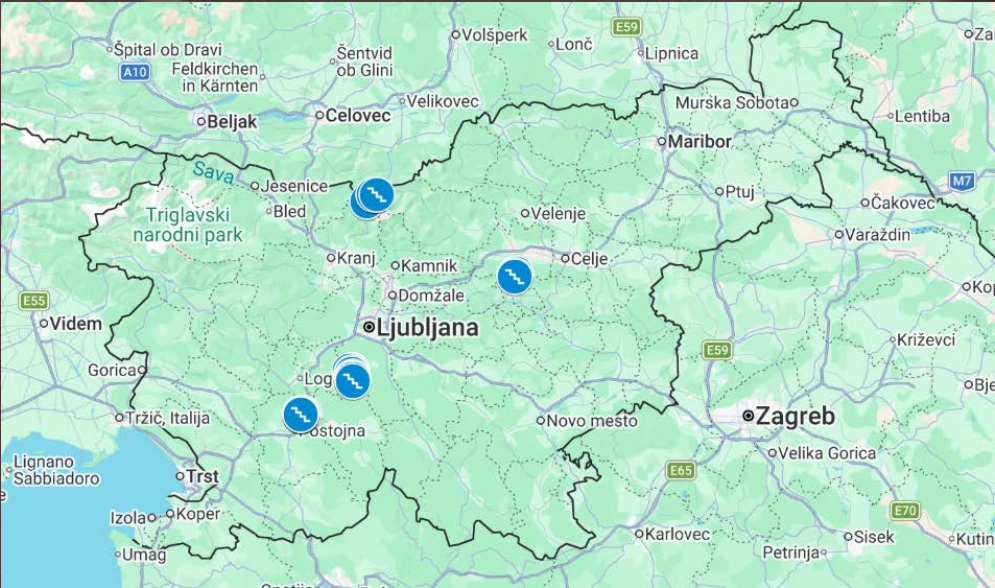
SLOVENIAN INFRASTRUCTURE AGENCY

Webinar on Road Marking

Uroš Brumec, MSc TT



SPECIAL ROAD MARKINGS FOR MOTORCYCLISTS





SPECIAL ROAD MARKINGS FOR MOTORCYCLISTS

FIRST PILOT PROJECT - June/July 2016



Oddelek za geotehniko in prometnice
Odsek za vzdrževanje in gospodarjenje s cestami

Ljubljana, 25.08.2017

POROČILO

št. P 820/17-720-1

O meritvah tornih lastnosti s prenosnim nihalom SRT
in po metodi zapolnitve s peskom

Naročnik: Ministrstvo za infrastrukturo, Direkcija Republike Slovenije za
infrastrukturo, Tržaška 19, 1000 Ljubljana
Naročilo/pogodba: Naročilnica št. N2431-17-0447, spis 450-1066/2017 z dne 18.8.2017

Nosilec naloge:
mag. Darko Kokot, univ. dipl. inž. grad.

Vodja odseka:
mag. Darko Kokot, univ. dipl. inž. grad.

Direktor:
izvr. prof. dr. Andrej Legat, univ. dipl. fiz.

Rezultati preskušanja se nanašajo izključno na merjene odseke cest v času izvajanja meritev. Poročilo se sme reproducirati samo v celoti. Rok za reklamacije je 15 dni od izdaje poročila. Skupno število strani: 16 (10+6), št. prilog: 1 (6 strani).

Obr. P.S. 12-001-01/2

Št.: P 820/17-720-1

ZAG

Stran: 7/10

Kot je iz Preglednice 3 razvidno, je stanje v posameznih krivinah, na posameznih tleh označbah znatno posamezne krivine, precej raznoliko. Praktično za vsako krivino lahko rečemo, da smo merili na vsaj eni tleh označbi, katere odpor proti drsenju lahko naravnostno v razred S3 ali v S2, posledica pa celo S1.

Na naslednjih slikah je prikazanih nekaj obrabljenih ali poškodovanih tleh označbah. Bolj obrabljene strani označbah so širše, ob katere zadane prevoznika vozila v smeri vožnje, posledice (poniski delov. označb v smeri prometa) pa so se pojavile predvsem v glavnem zaradi velikih sil pri zaviranju.



Slika 4: Obrabljen začetni rob tleh označbe v smeri poteka prometa



Slika 5: Zamaknjen del tleh označbe

Rezultati preskušanja se nanašajo izključno na preskušene primere. Poročilo se sme reproducirati samo v celoti.
Obr. P.S. 12-001-01/2

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ZAG

Stran: 8/10



Slika 6: Zamaknjen del in odrgen drugi del tleh označbe



Slika 7: Več poškodovanih zaporednih tleh označbah

Rezultati preskušanja se nanašajo izključno na preskušene primere. Poročilo se sme reproducirati samo v celoti.
Obr. P.S. 12-001-01/2

Minimum SRT value classes under SIST EN 1436:2007 + A1:2009

Class	Minimum SRT value
S0	No specified value
S1	SRT ≥ 45
S2	SRT ≥ 50
S3	SRT ≥ 55
S4	SRT ≥ 60
S5	SRT ≥ 65

Key findings

- The corrected average values for the eight curves are 55, 55, 54, 50, 54, 51, 54 and 52 SRT.
- The lowest corrected curve average is 50 SRT and the highest is 55 SRT.
- The overall range of individual corrected values across all measured markings is 48 to 59 SRT.
- The class of each curve is determined from the corrected average of five markings in that curve. Accordingly, the two curves averaging 55 SRT are class S3, while the remaining six curves averaging 50 to 54 SRT are class S2.
- In addition to skid resistance results, the ZAG report documents wear, displacement and detached parts of certain markings. The SRT classification is therefore not an assessment of their mechanical condition.



Monitoring učinkovitosti izvedenih ukrepov
za izboljšanje prometne varnosti
na DC R3-643/1436,
med km 4,300 in km 8,600 (15 krivin)



Conclusion:

Following the implementation of the special motorcycle road markings, motorcyclists generally adopted a safer riding position and trajectory through curves, maintaining a greater distance from the centerline and remaining within their lane more consistently. As a result, encroachment into the opposing traffic lane decreased, indicating a positive effect of the markings on rider behavior, lane discipline, and overall road safety.

Furthermore, the number of motorcycle crashes in the treated curves decreased by approximately 71%, confirming the effectiveness of the measure.

1. nasprotnosmerni vozni pas;
2. vozni pas: po/preko posebnih označbah – tik ob sredinski črti;
3. vozni pas: po/preko posebnih označbah – ostala površina;
4. vozni pas: tik ob posebnih označbah;
5. vozni pas: levo od sredine neoznačenega pasu ceste;
6. vozni pas: po sredini neoznačenega pasu ceste (med označbami in robno črto);
7. vozni pas: desno od sredine neoznačenega pasu ceste
8. vozni pas: ob desnem robu smernega vozišča;
9. vozni pas: robni pas.

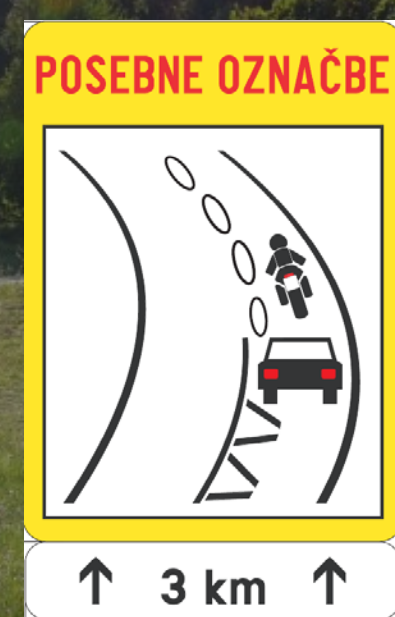
Slika 3.5: Primer delitve preseka krivine na devet segmentov





Driving dynamics in the curves with special markings for motorcyclists





SPECIAL ROAD MARKINGS FOR MOTORCYCLISTS SECOND & THIRD PILOT PROJECT – September 2023





Monitoring v štirih krivinah na DC R1-210/1105 "Jezersko"

Končno poročilo o rezultatih meritev po izvedbi ukrepov

Št. pogodbe: 2431-20-001531/0
5/041-2020

COBISS ID: 209395971

NAROČNIK: Ministrstvo za infrastrukturo,
Direkcija Republike Slovenije za infrastrukturo
Tržaška cesta 19, 1000 Ljubljana

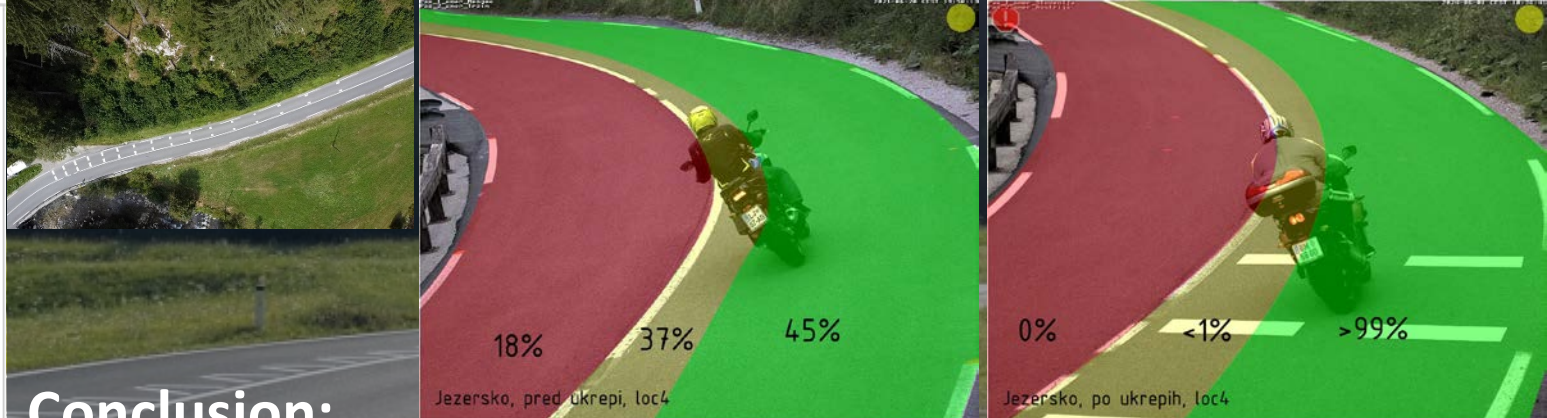
IZVAJALEC: Univerza v Ljubljani,
Fakulteta za strojništvo,
Katedra za modeliranje v tehniki in medicini (KMTM)
Aškerčeva cesta 6, 1000 Ljubljana

i. prof. dr. Robert Kunc,
predstojnik katedre



prof. dr. Mihael Sekavčnik
dekan

Ljubljana, december 2023



Conclusion:

Following the implementation of the special motorcycle road markings, motorcyclists adopted a safer riding position and trajectory through curves. Riders travelled further away from the centreline, remained more consistently within their lane, and crossed the centerline less frequently. On average, the distance from the centreline increased by approximately 44%, while centerline encroachments were reduced by approximately 50%. The results demonstrate that the markings positively influence rider behavior and improve overall road safety by reducing the risk of conflicts with oncoming traffic.

Illustration of the measure:

At Location 4, centerline encroachments were virtually eliminated after the implementation of the markings, with almost all riders remaining within the safe riding zone of their lane.

Monitoring v petih krivinah na DC R2-427/1351 "Marija Reka"

Končno poročilo o rezultatih meritev po izvedbi ukrepov

Avtorji:

Jernej Korinšek

Domen Guštin

doc. dr. Miha Ambrož, univ. dipl. inž.

Aleksander Novak, mag. inž. stroj.

asist. Urban Žnidaršič, univ. dipl. inž.

asist. dr. Matej Kranjec, univ. dipl. inž.

doc. dr. Simon Krašna, univ. dipl. inž.

doc. dr. Andrej Žerovnik, univ. dipl. inž.

doc. dr. Samo Zupan, univ. dipl. inž.

Slobodanka Ivanjić Kostreševič, univ. dipl. prev.

izr. prof. dr. Robert Kunc, univ. dipl. inž.

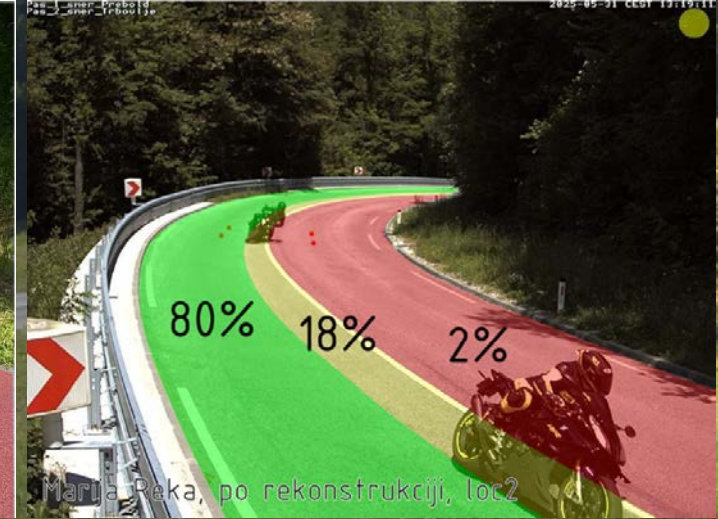
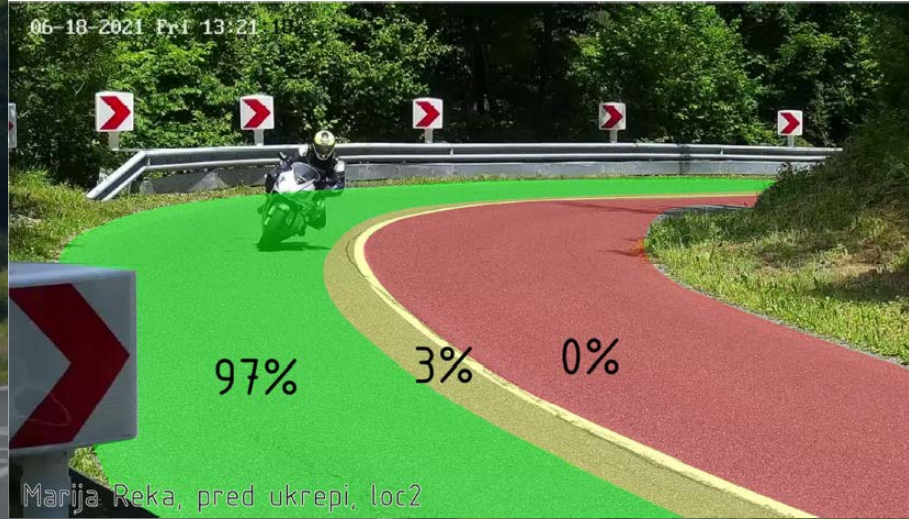
Ljubljana, september 2025

Conclusion:

Following the implementation of the special motorcycle road markings, motorcyclists adopted safer riding trajectories and positioned themselves further away from the centerline. On all treated locations, the proportion of riders travelling within the hazardous zone adjacent to the centerline was significantly reduced, while the average distance from the centerline increased. The results demonstrate that the road markings effectively encourage riders to remain within their lane, reduce centerline encroachment, and decrease the likelihood of a motorcycle or rider's body entering the opposing traffic lane.

The most pronounced effect was observed at Location 4, where the proportion of riders travelling in the hazardous zone was reduced by approximately 81%, and the average distance from the centerline increased by nearly 49%.

Overall, the study confirms that special motorcycle road markings positively influence rider behavior, improve lane discipline in curves, and contribute to enhanced road safety.



Location 2 (reconstructed section):

At Location 2, no special motorcycle road markings were installed. Instead, a complete reconstruction of the roadside slope, safety barrier with raised curb, and pavement was carried out. Following the reconstruction, the average riding speed decreased by approximately 7%; however, the proportion of motorcyclists riding within the hazardous zone near the centerline increased significantly, from 3% to 20%. The average distance from the centerline also decreased from 1.18 m to 0.85 m. These findings indicate that, unlike the locations where special road markings were implemented, the reconstruction alone did not improve rider positioning relative to the centerline.

Key finding: the greatest improvements in lane positioning and centerline avoidance were observed at locations where special motorcycle road markings were installed, whereas the reconstructed section without such markings did not achieve similar behavioral benefits.



SPECIAL ROAD MARKINGS FOR MOTORCYCLISTS

FOURTH PILOT PROJECT – June 2025

Detekcija in analiza voznških in psihofizičnih
odzivov voznikov na področju ceste R2-409 odsek
Planina-Ravbarkomanda

Poročilo 1. faze projekta

Izvajalec: Univerza v Ljubljani, Fakulteta za elektrotehniko
Sodelujoči:
izr. prof. dr. Gregor Jakus
doc. dr. Kristina Stojmenova Železnik
prof. dr. Jaka Sadnik

Ljubljana, 15.11.2023



UNIVERZA
V LJUBLJANI



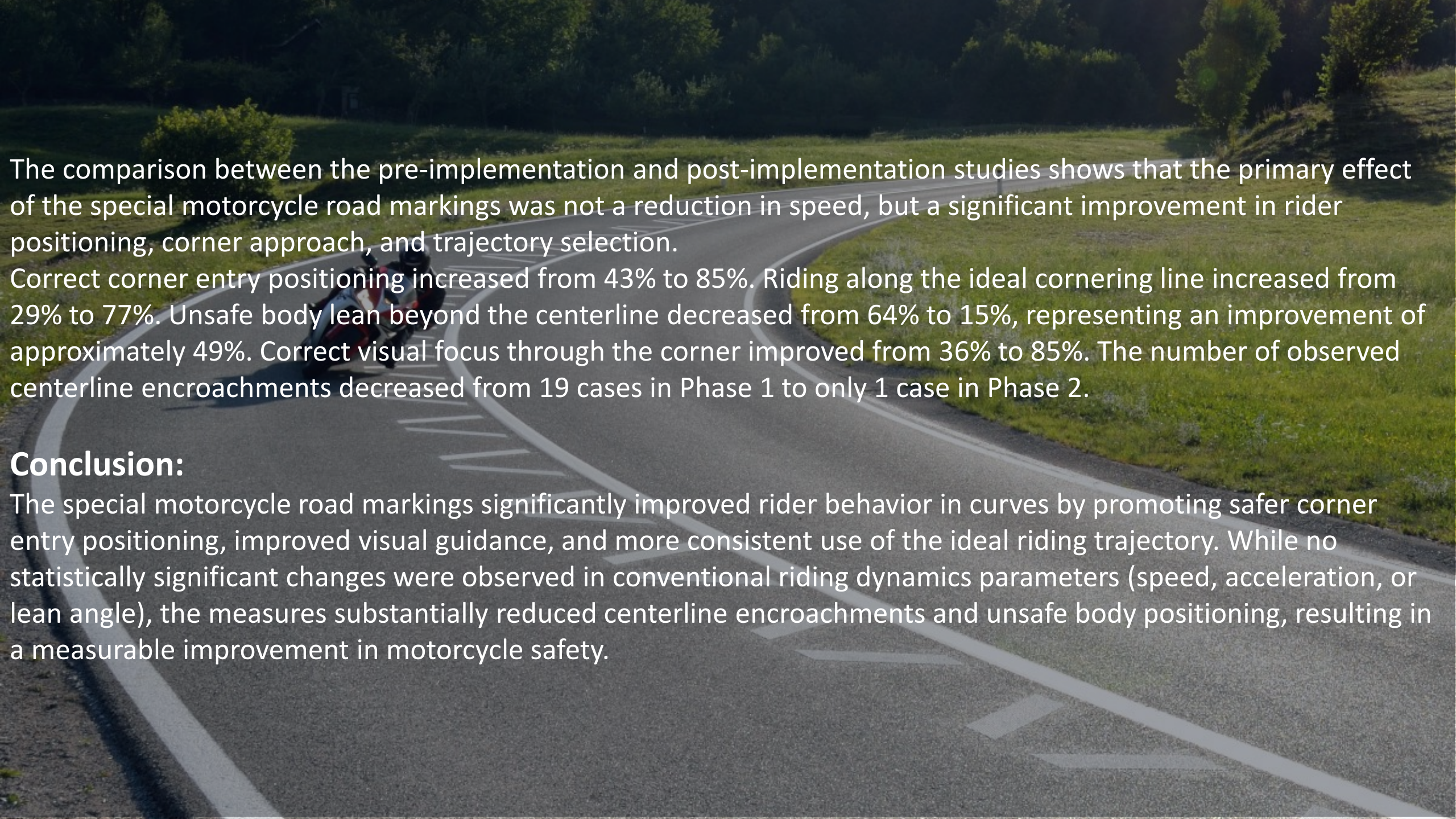
INSTITUT
ZA AVTOMATIZACIJO
IN INFORMATIKO

Detekcija in analiza voznških in psihofizičnih
odzivov voznikov na področju ceste R2-409 odsek
Planina-Ravbarkomanda

Poročilo 2. faze projekta

Sodelujoči:
prof. dr. Jaka Sadnik (vodja)
izr. prof. dr. Gregor Jakus
Andrej Orglitz
Simon Pestovnik



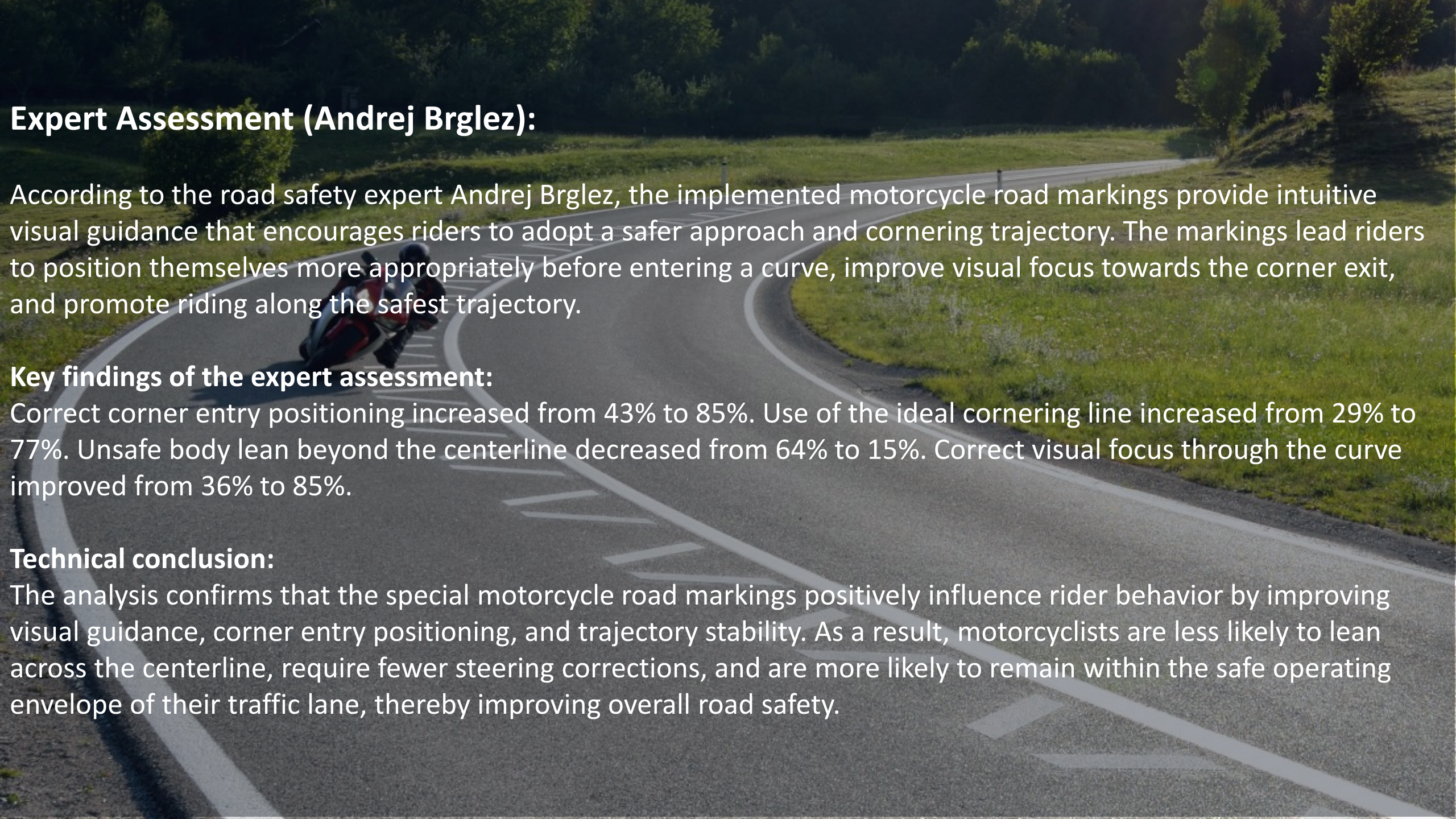
A photograph of a motorcycle riding on a paved road that curves to the right. The road has white painted markings, including a solid line on the left, a dashed line in the center, and a solid line on the right. The motorcycle is positioned in the center of the road, leaning into the curve. The background shows green grass and trees under a clear sky.

The comparison between the pre-implementation and post-implementation studies shows that the primary effect of the special motorcycle road markings was not a reduction in speed, but a significant improvement in rider positioning, corner approach, and trajectory selection.

Correct corner entry positioning increased from 43% to 85%. Riding along the ideal cornering line increased from 29% to 77%. Unsafe body lean beyond the centerline decreased from 64% to 15%, representing an improvement of approximately 49%. Correct visual focus through the corner improved from 36% to 85%. The number of observed centerline encroachments decreased from 19 cases in Phase 1 to only 1 case in Phase 2.

Conclusion:

The special motorcycle road markings significantly improved rider behavior in curves by promoting safer corner entry positioning, improved visual guidance, and more consistent use of the ideal riding trajectory. While no statistically significant changes were observed in conventional riding dynamics parameters (speed, acceleration, or lean angle), the measures substantially reduced centerline encroachments and unsafe body positioning, resulting in a measurable improvement in motorcycle safety.

A photograph of a motorcycle riding on a winding asphalt road. The road features special white markings, including a series of chevron-like arrows pointing towards the center of the curve. The motorcycle is positioned on the left side of the road, leaning into the turn. The background shows a grassy field and trees under a clear sky.

Expert Assessment (Andrej Brglez):

According to the road safety expert Andrej Brglez, the implemented motorcycle road markings provide intuitive visual guidance that encourages riders to adopt a safer approach and cornering trajectory. The markings lead riders to position themselves more appropriately before entering a curve, improve visual focus towards the corner exit, and promote riding along the safest trajectory.

Key findings of the expert assessment:

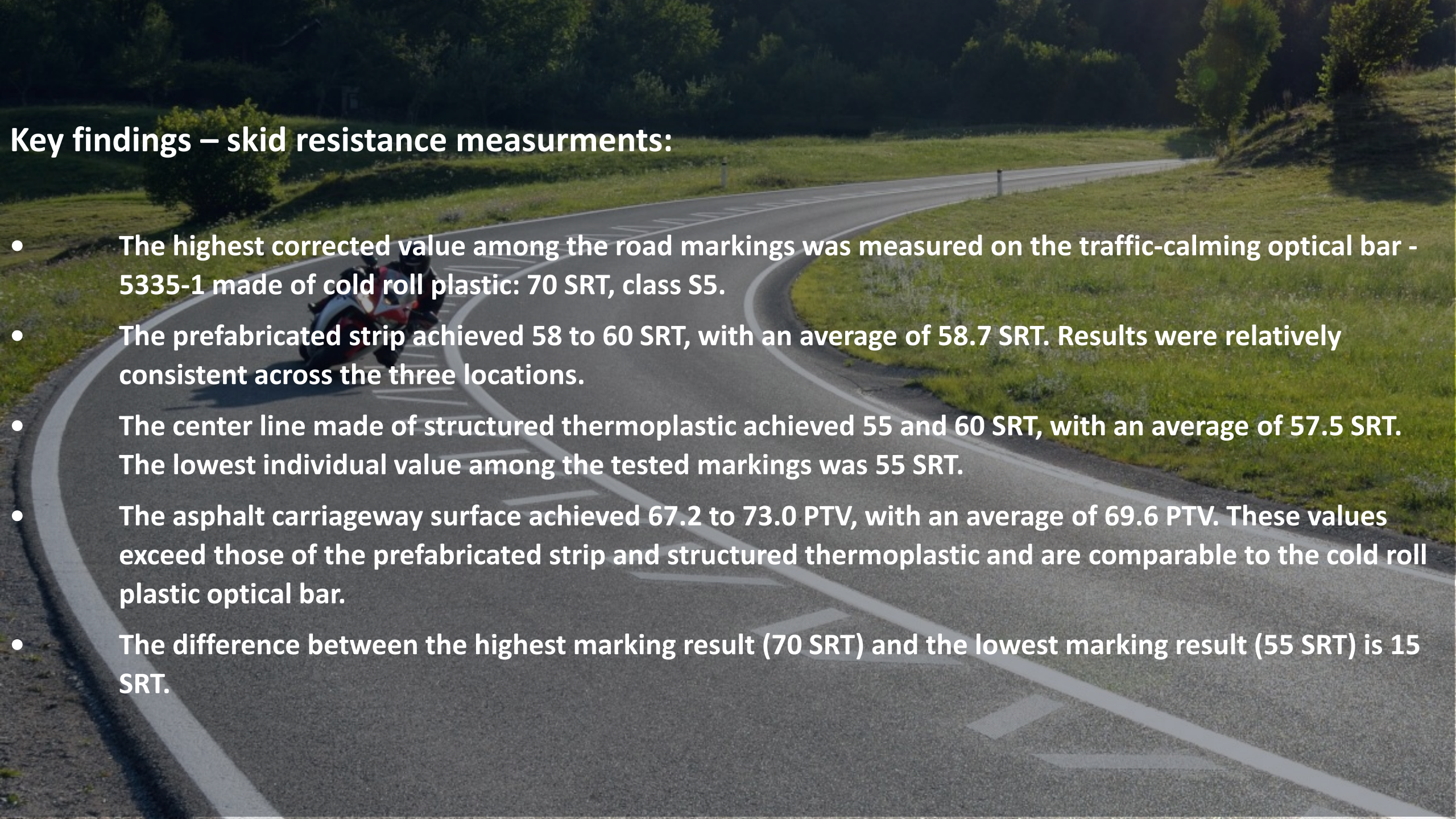
Correct corner entry positioning increased from 43% to 85%. Use of the ideal cornering line increased from 29% to 77%. Unsafe body lean beyond the centerline decreased from 64% to 15%. Correct visual focus through the curve improved from 36% to 85%.

Technical conclusion:

The analysis confirms that the special motorcycle road markings positively influence rider behavior by improving visual guidance, corner entry positioning, and trajectory stability. As a result, motorcyclists are less likely to lean across the centerline, require fewer steering corrections, and are more likely to remain within the safe operating envelope of their traffic lane, thereby improving overall road safety.



Parameter	Phase 1 (Before Implementation)	Phase 2 (After Implementation)	Change
Correct corner entry positioning	43%	85%	+42 percentage points
Riding along the ideal trajectory	29%	77%	+48 percentage points
Riders exhibiting unsafe body lean beyond the centreline	64%	15%	-49%
Correct visual focus through the corner	36%	85%	+49 percentage points
Observed centreline crossings	19 cases	1 case	-95%

A photograph of a winding asphalt road with various white road markings, including a center line and dashed lines. A motorcycle is visible on the road, leaning into a curve. The background shows green grass and trees under a clear sky.

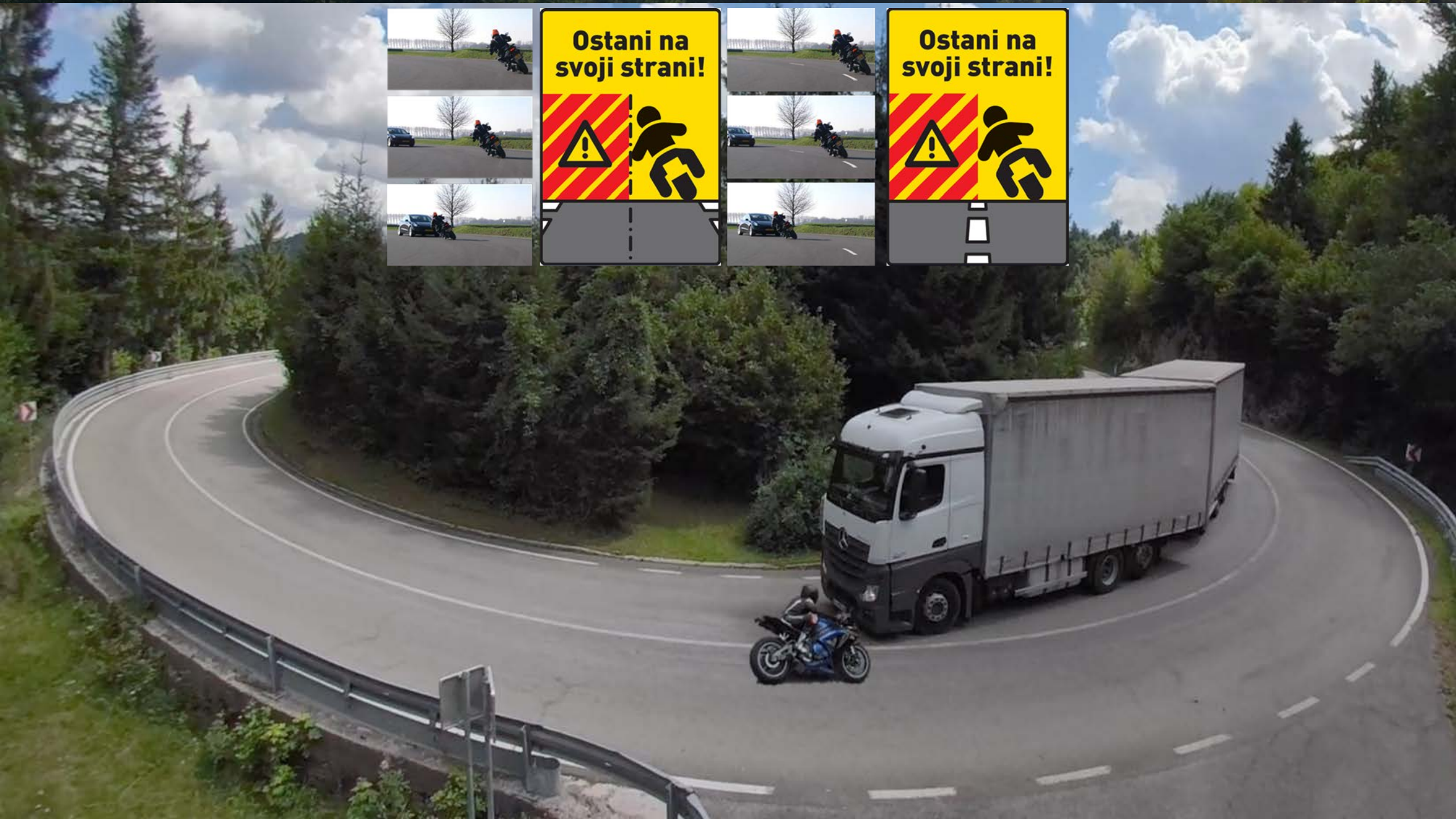
Key findings – skid resistance measurements:

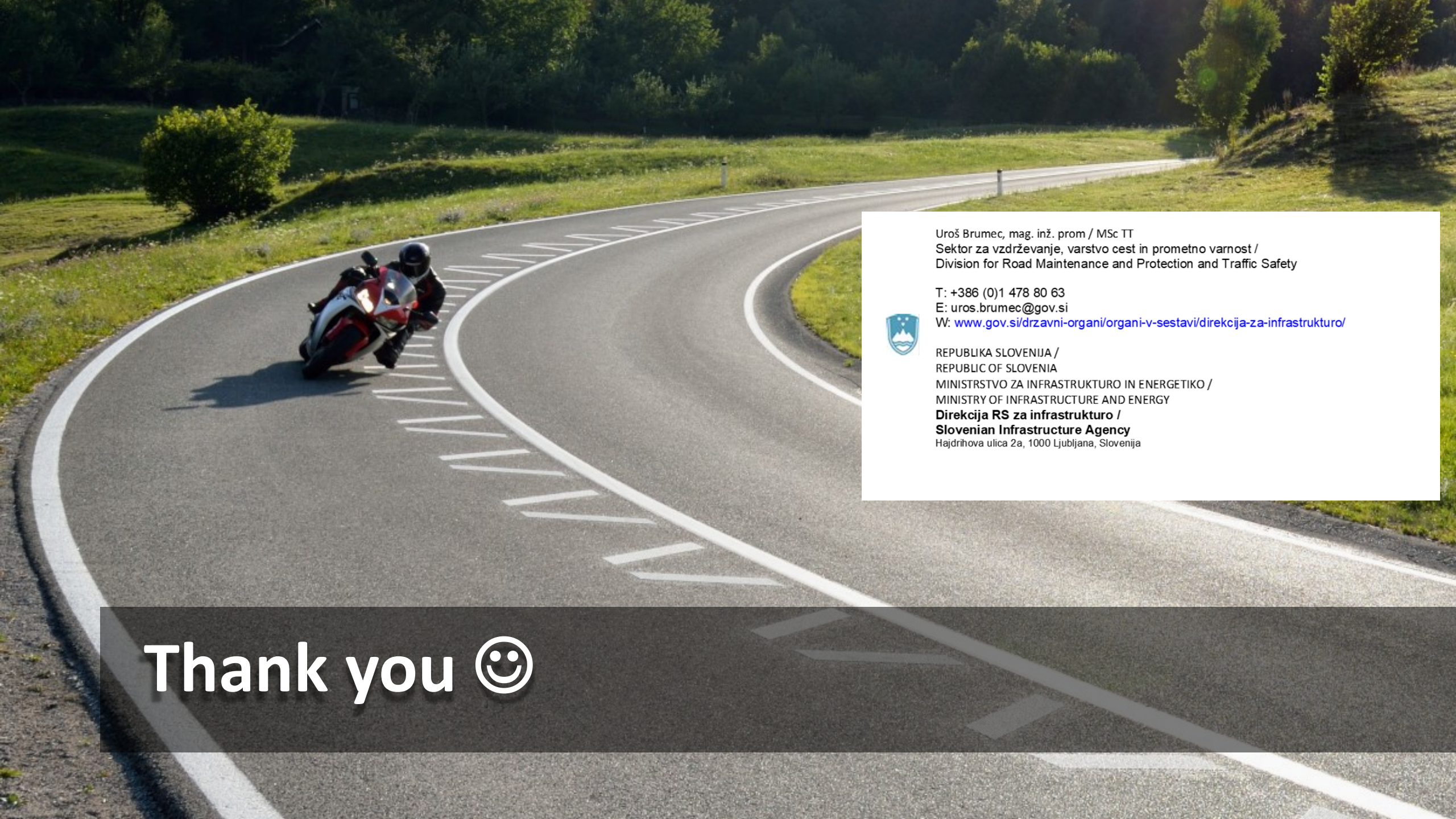
- The highest corrected value among the road markings was measured on the traffic-calming optical bar - 5335-1 made of cold roll plastic: 70 SRT, class S5.
- The prefabricated strip achieved 58 to 60 SRT, with an average of 58.7 SRT. Results were relatively consistent across the three locations.
- The center line made of structured thermoplastic achieved 55 and 60 SRT, with an average of 57.5 SRT. The lowest individual value among the tested markings was 55 SRT.
- The asphalt carriageway surface achieved 67.2 to 73.0 PTV, with an average of 69.6 PTV. These values exceed those of the prefabricated strip and structured thermoplastic and are comparable to the cold roll plastic optical bar.
- The difference between the highest marking result (70 SRT) and the lowest marking result (55 SRT) is 15 SRT.











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REPUBLIKA SLOVENIJA /
REPUBLIC OF SLOVENIA

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MINISTRY OF INFRASTRUCTURE AND ENERGY

Direkcija RS za infrastrukturo /
Slovenian Infrastructure Agency

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Thank you 😊