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office@nievelt.at
A-2000 Stockerau Wiener Straße 35 T: +43-(0)2266-64110 F: +43-(0)2266-65897
A-6060 Hall in Tirol Lorettostraße 26 T: +43-(0)5223-42106 F: +43-(0)5223-42173
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Stockerau, mb/ah

Client: Baumit Wopfinger Baustoffindustrie GmbH
Wopfing 156
2754 Waldegg

Order from: 30.09.2010

PROJECT REPORT

on the comparative evaluation of asphalt layer characteristics with and without hydrated lime modification

Test track B62 Lackendorf

Scope:

18	Pages total, thereof
13	Pages report
1	Enclosure (5 pages)
3	Picture(s)
-	Graphics

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Akkreditierte Prüf- u. Überwachungsstelle
A-2000 Stockerau Wiener Straße 35
Tel.: +43-(0)2266-64110 Fax +43-(0)2266-65897

– The test results are valid only in reference to the evaluated material –

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1. GENERAL

Nievelt Labor GmbH was assigned by Baumit Wopfinger Baustoffindustrie GmbH, represented by Mr. Dipl.-Ing. Christof Kunesch, to attend the test track B62 Lackendorf in order to compare the evaluation of the surface status display as well as the existing rut depths after an exposure time of appr. six years.

In the course of required rehabilitation works due to heavy rut depths the upper cross section of asphalt construction of B62, road section Lackendorf, has been milled and new layers were placed. At the beginning of the construction phase a 300 m long test track was installed according to the requirements of the tender, where asphalt layers with hydrated lime have been placed.

In order to evaluate the characteristics of modified asphalt layers with hydrated lime subsequently the same asphalt mixtures (asphalt surface course and asphalt binder layer) were placed with polymer-modified bitumen.

In the year 2004 the following stated asphalt layers were placed in the course of the asphalt construction rehabilitation works at the B62 Lackendorf.

table 1

asphalt mix type **Comparative track** (without hydrated lime)	Product description according to valid ÖNORM B 3580-1
BT 32 HS LK S, PmB 30-50	AC 32 binder PmB 25-55/65, H1, G4
pmAB 11 LK S, PmB 60-90	AC 11 deck PmB 45-80/50, A2, G1

table 2

asphalt mix type **Test track** (with hydrated lime)	Product description according to valid ÖNORM B 3580-1
BT 32 LK S, 70/100, 3,5 M.-% hydrated lime	AC 32 trag 70/100, T1, G4, Ka30
AB 11 LK S, 70/100, 3,5 M.-% hydrated lime	AC 11 deck 70/100, A1, G1, Ka30

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According to the comparative evaluation of the surface status display and the measurement of the rut depths over a longer period of time the performance of both constructions should be evaluated.

2. BASICS OF THIS REPORT

2.1 Asphalt mixture production and type testing

Without exception only asphalt mixture of the asphalt plan St. Martin was delivered for the carrying out of the rehabilitation works. The type testings were conducted for the asphalt mix types with hydrated lime modification as well as for the asphalt mix types without hydrated lime modification by TPA, Gesellschaft für Qualitätssicherung und Innovation GmbH, 1220 Vienna.

For the purpose of comparison, the asphalt base course mixtures of the type BT 32 LK S, 70/100 (AC 32 trag 70/100, T1, G4) and the asphalt surface course mixtures AB 11 LK S, 70/100 (AC 11 deck 70/100, A1, G1) were produced at the asphalt mixing plant respectively at the laboratory with the same mineral aggregates and comparative volumetric concepts. These asphalt mixture types were only produced and tested for the purpose of comparison, but not laid down at the road project B62.

The summary of the type testing results is shown in the Nievelt Labor GmbH's report A0310-04-3 from 17.11.2004.

The following tables include the relevant specific values of this type testing as an *excerpt of the aforementioned report.*

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A-2000 Stockerau Wiener Straße 35
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table 3

Type testing – Asphalt base course mixture

Characteristics	*BT 32 HS - LK S*	*BT 32 - LK S*	*BT 32 - LK S*
	PmB 30-50	*B 70/100 + 3,5 M.-% hydrated lime*	*B 70/100*
Asphalt plant	*St. Martin*		*Laboratory mixture*
Binder content in % by mass	*4,9*	*4,7*	*4,4*
Mineral aggregates	*EBK 0/2 ex Ottersböck, EBK 2/32 ex Pauliberg*		
Filler content in % by mass	*6,2*	*7,1*	*7,5*
Sand content in % by mass	*20,8*	*24,3*	*25,1*
Chip material in % by mass	*72,9*	*68,6*	*67,4*
Coarse aggregate content in % by mass	*18,7*	*19,6*	*17,9*
Void content in % by vol.	***4,4***	***4,4***	***4,6***
Marshall stability in kN	*17,5*	*11,9*	*12,8*

tabe 4

Type testing – Asphalt base course mixture

Characteristics	*pmAB 11 - LK S*	*AB 11 - LK S*	*AB 11 - LK S*
	PmB 60-90	*B 70/100 +3,5 M.-% hydrated lime*	*B70/100*
Asphalt plant	*St. Martin*		
Binder content in % by mass	*6,0*	*5,8*	*5,5*
Mineral aggregates	*EBK 0/2 ex Ottersböck, EBK 2/11 ex Pauliberg*		
Filler content in % by mass	*7,7*	*9,0*	*9,3*
Sand content in % by mass	*30,9*	*30,1*	*30,9*
Chip material in % by mass	*61,4*	*60,9*	*59,8*
Coarse aggregate content in % by mass	*22,2*	*20,2*	*21,1*
Void content in % by vol.	***3,8***	***3,8***	***3,7***
Marshall stability in kN	*11,9*	*11,0*	*11,8*

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2.2 Check testing

The current check testings were conducted by Nievelt Labor GmbH. The test results can also be taken in detail from the Report A0310-04-3. The following tables include the relevant specific values in extracts.

table 5

Test results – Asphalt base course mixture

Characteristics	*Unit*	*BT 32 HS - LK S PmB 30-50*	*BT 32 - LK S B70/100 + hydrated lime*	*BT 32 - LK S B70/100*
Binder content	*% by mass*	*4,8*	*4,5*	*4,6*
Void in mineral aggregate	*% by vol.*	*17*	*17*	*15*
Voids filled with bitumen	*% by vol.*	*71*	*64*	*78*
Filler-/Bitumen ratio	*%*	*1,5*	*1,4*	*1,7*
Filler content	*% by mass*	*7,0*	*6,2*	*7,8*
Sand content 0,09 – 2,0 mm	*% by mass*	*23,9*	*27,6*	*24,7*
Aggregate content > 2,0 mm	*% by mass*	*69,1*	*66,2*	*67,5*
Coarse aggregate (> 22 mm)	*% by mass*	*17,1*	*15,4*	*18,3*

table 6

Specific values	*Unit*	*Compaction temperature = 135°C*			*Compation temperature = 160°C*	
		BT 32 HS PmB 30-50	*BT 32 LK S B70/100 + hydrated lime*	*BT 32 LK S B70/100*	*BT 32 HS PmB 30-50*	*BT 32 LK S B70/100 + hydrated lime*
Bulk density Marshall specimen	*g/cm³*	*2,551*	*2,463*	*2,584*	*2,559*	*2,475*
Void content Marshall specimen	*Vol.-%*	*4,8*	*6,0*	***3,6***	***4,5***	***5,5***
Marshall stability	*kN*	*15,0*	*11,0*	*12,0*	*15,5*	*11,5*
Marshall flow	*mm*	*4,8*	*4,7*	*5,0*	*5,0*	*4,0*
Indirect tensile strength at -20 °C	*MPa*	*4,4*	*4,0*	*3,9*	*4,8*	*4,2*
Fracture track	*mm*	*2,1*	*1,9*	*1,9*	*2,0*	*2,2*

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table 7

Test results – Asphalt surface course mixture

Characteristics	*Unit*	*pmAB 11 LK S PmB 60-90*	*AB 11 LK S B70/100 + hydrated lime*	*AB 11 LK S B 70/100*
Binder content	*% by mass*	*6,0*	*5,5*	*5,3*
Void in mineral aggregate	*% by vol.*	*19*	*18*	*18*
Voids filled with bitumen	*% by vol.*	*77*	*75*	*73*
Filler-/Bitumen ratio	*%*	*1,4*	*1,4*	*1,6*
Filler content	*% by mass*	*8,7*	*7,8*	*8,3*
Sand content 0,09 – 2,0 mm	*% by mass*	*38,2*	*32,9*	*32,2*
Aggregate content > 2,0 mm	*% by mass*	*53,1*	*59,3*	*59,5*
Coarse aggregate (> 22 mm)	*% by mass*	*18,8*	*24,7*	*23,8*

table 8

Characteristics	*Unit*	*Compaction temperature 135°C*		
		PmB 60-90	*B70/100 + hydrated lime*	*B70/100*
Bulk density Marshall specimen	*g/cm³*	*2,487*	*2,511*	*2,513*
Void content Marshall specimen	*Vol.-%*	*4,2*	*4,5*	*5,0*
Marshall stability	*kN*	*11,5*	*9,8*	*11,5*
Marshall flow	*mm*	*4,2*	*3,6*	*4,1*
Indirect tensile strength at -20 °C	*MPa*	*4,4*	*4,2*	*4,1*
Fracture track	*mm*	*1,9*	*1,9*	*1,8*

2.3 Rutting resistance

In the course of a so called extended receiving inspection the rutting resistance of the asphalt mixture types stated in item 2.1 was evaluated according to RVS 11.06.64. Meanwhile this RVS was replaced by ÖNORM EN 12697-22 and the test instruction corresponds to the rutting test "with the large wheel".

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The following tables content extracts of the relevant characteristic rut depth values determined in course of the type testing.

table 9

Resistance to permanent deformation - Asphalt base course mixture

Characteristics	*BT 32 HS - LK S*	*BT 32 - LK S*	*BT 32 - LK S*
	PmB 30-50	*B70/100 + hydrated lime*	*B70/100*
Binder content in % by mass	*4,8*	*4,5*	*4,6*
Void content in % by vol. at 135 °C	*4,8*	*6,0*	*3,6*
Filler content in % by mass	*7,0*	*6,2*	*7,8*
Rutting resistance			
Average value taken from 2 test plates	***3,6***	***6,6***	***10,7***
Standard according to RVS 8S.01.41	*≤ 7 %*	*no requirement*	*no requirement*

table 10

Resistance to permanent deformation – Asphalt surface course mixture

Specific values	*pmAB 11 - LK S*	*AB 11 - LK S*	*AB 11 - LK S*
	PmB 60-90	*B70/100 + hydrated lime*	*B70/100*
Binder content in % by mass	*6,0*	*5,5*	*5,3*
Void content in % by vol. at 135 °C	*4,2*	*4,5*	*5,0*
Filler content in % by mass	*8,7*	*7,8*	*8,3*
Rutting resistance			
Average value	***4,0***	***5,7***	***10,2***
Standard according to RVS 8S.01.41 type testing	*≤ 10 %*	*no requirement*	*no requirement*
Standard according to RVS 8S.01.41 Acceptance testing / check testing	*≤ 12 %*	*no requirement*	*no requirement*

Nievelt Labor GmbH
Akkreditierte Prüf- u. Überwachungsstelle
A-2000 Stockerau Wiener Straße 35
Tel.: +43-(0)2266-64110 Fax +43-(0)2266-65897

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2.4 Results of the type and check testings

As a summary of the tests conducted in the year 2004 the following conclusion can be extracted from report A0310-04-3 (*excerpt from item 5*):

The conducted tests mainly intended to determine the resistance to permanent deformation of asphalt base courses and asphalt surface courses modified with hydrated lime and to oppose the results to the currently valid rules and standards.

Regarding the said criteria it is to clearly declare, that the asphalt mixture types

- *BT 32 LK S and*
- *AB 11 LK S*

produced with paving grade bitumen 70/100 and the additive hydrated lime "Baumit Spezikalk CL90 Super" according to RVS 8S.01.41 can be indicated as resistant to deformation.

The determined specific values of the hydrated lime modified asphalt mixture are scarcely below to those of polymer modified asphalt mixture, but well above the characteristic values reached by asphalt mixtures produced with binder 70/100 according to EN 12591.

The same applies analogously for the results of the conducted indirect tensile tests at -20 °C.

Based on the conducted tests and the presented results of asphalt mixture produced with paving grade bitumen 70/100 and the additive hydrated lime good asphalt-mechanical characteristics can be confirmed for both a

- *high temperature range (deformation resistance) as well as for a*
- *low temperature range (low-temperature performance, vulnerability to crack formation).*

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A-2000 Stockerau Wiener Straße 35
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2.5 Monitoring of the surface characteristics in the years from 2005 to 2007

For the purpose of monitoring the surface characteristics and the rut depth of the two constructional systems Baumit Wopfinger Baustoffindustrie GmbH assigned Nievelt Ingenieur GmbH in the years 2005, 2006 and 2007 to evaluate the surface status display of the asphalt constructions as well as to compare the rut depth of the sections with hydrated lime modification to those with no modification.

In total eight cross profiles were covered with the measurement device "Planum" (on each lane two profiles in a section with and two profiles in a section without hydrated lime modification) and the rut depth over the whole roadway width was registered continuously.

The final report A0143-07 of 31.08.2007 on the determined surface characteristics for the first three years after rehabilitation works contains the following summary *(excerpt from item 3)*:

(1)
Comparing the determined cross-evenness of the years 2005 to 2007 at the individual cross profiles, the measurements from 2005 and 2006 of the section where the asphalt layers contain the additive "hydrated lime" as well as of the section where the asphalt layers contain the additive "PmB", only marginally higher plastic deformation can be detected. Dependent on the cross profile the increase in plastic deformation amounts from 0 to a maximum of 4 mm. Also in the period from 2006 to 2007 no significant increase in plastic deformation has been registered at all measurement profiles.

(2)
Taking the conducted measurements of the cross-evenness with the measurement device "Planum" as a basis it can be stated that the deformation resistance of the asphalt layers of B62 Lackendorf under current load and climatic conditions, based on the additive "hydrated lime", is high and that, compared to the asphalt layers based on the additive "PmB" no differences regarding rutting were determined.

3. SURFACE CHARACTERISTICS AFTER 6 YEARS EXPOSURE TIME

Subsequent to an exposure time of six years Nievelt Labor GmbH was again assigned to assess the test/comparative track's surface characteristics as well as rut depths.

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The measurement of the rut depths was effected on the same measurement profile as it was used for measurements in the years from 2005 to 2007. Parallel to these measurements a photo documentation of the surface status display was created.

3.1 Surface status display

Evidently the asphalt surface course modified with hydrated lime does not differ from the one assembled with polymer-modified bitumen. Both asphalt layers do not show fretting or other surface damages like crack formation. The following pictures document the status display of the asphalt surface course produced with hydrated lime as additive.

Picture 1: Overview test track with hydrated lime

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A-2000 Stockerau Wiener Straße 35
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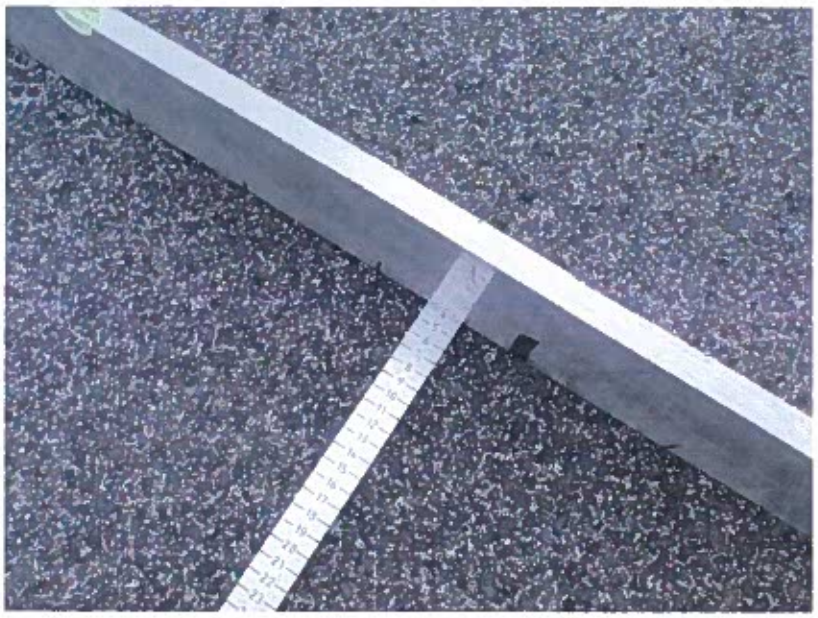

Picture 2: Rut measurement at profile no. 2, km 3,613

Picture 3: Surface texture of the asphalt surface course with hydrated lime

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3.2 Rut measurement

The rut measurement was effected over the whole roadway width by use of the measuring device "Planum" and a 2 m-rod according to RVS 11.06.62.

The following table shows the results of the rut measurement with the 2 m-rod. Furthermore enclosure 1 to this report contains the registered cross profile.

table 11

Rut depth, single values – Asphalt surface course after 6 years

Asphalt layers built with …	Lane „St. Martin"			Lane „Horitschon"		
	Cross profile	Right wheel track in mm	Left wheel track in mm	Cross profile	Right wheel track in mm	Left wheel track in mm
polymer-modified bitumen (comparative track)	5 km 3,900	0	3	4 km 3,900	4	1
	6 km 3,800	1	4	3 km 3,790	4	1
hydrated lime (test track)	7 km 3,660	5	5	2 km 3,613	4	2
	8 km 3,530	4	4	1 km 3,543	5	2

table 12

Rut depth, average value – Asphalt surface course after 6 years

Asphalt layers built with …	Cross profile	Left wheel track in mm	Right wheel track in mm	**Average value in mm**
polymer-modified bitumen (comparative track)	3, 4, 5, 6	4	1	**2**
hydrated lime (test track)	1, 2, 7, 8	5	3	**4**

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4. SUMMARY

The conducted performance and check testings show that the resistance to permanent deformation of asphalt mixture composed of paving grade bitumen can be significantly improved by adding hydrated lime.

A comparison of the plastic deformations determined by the wheel tracking test shows that asphalt mixture types consisting of paving grade bitumen and hydrated lime hold significantly higher deformation resistance than asphalt mixture types based on paving grade bitumen, but less deformation resistance than asphalt mixture types based on polymer-modified bitumen.

In the years 2005, 2006 and 2007 the rut measurements effected on eight cross profiles on B62 Lackendorf did not reveal significant differences between the test track (paving grade bitumen and hydrated lime) and the comparative track (polymer-modified bitumen).

In course of the last measurement in autumn 2010 the test track (paving grade bitumen and hydrated lime) shows slightly increased deformation than the comparative track (polymer-modified bitumen). The differences observed on the roads meet the conclusions from the type testings. After a service life of six years the test track shows an average rut depth of 4 mm, compared to an average rut depth of 2 mm on the comparative track; in general both are on a low level.

The surface status display of both the test track and the comparative track are free from crack formation and other surface damages. Visually no difference between the two asphalt surface course systems can be identified.

Nievelt Labor GmbH
Akkreditierte Prüf- u. Überwachungsstelle
A-2000 Stockerau Wiener Straße 35
Tel. +43-(0)2266-64110 Fax +43-(0)2266-65897

Authorized signatory
ing. Helmut Nievelt

Head of the test laboratory
Dr. Martin Buchta

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ENCLOSURE 1

Cross-evenness with the measurement device "Planum"

Cross profiles 1, 2, 7 and 8 (paving grade bitumen with hydrated lime)

Cross profiles 3, 4, 5 and 6 (polymer-modified bitumen)

(1+4 pages)

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A-2000 Stockerau Wiener Straße 35
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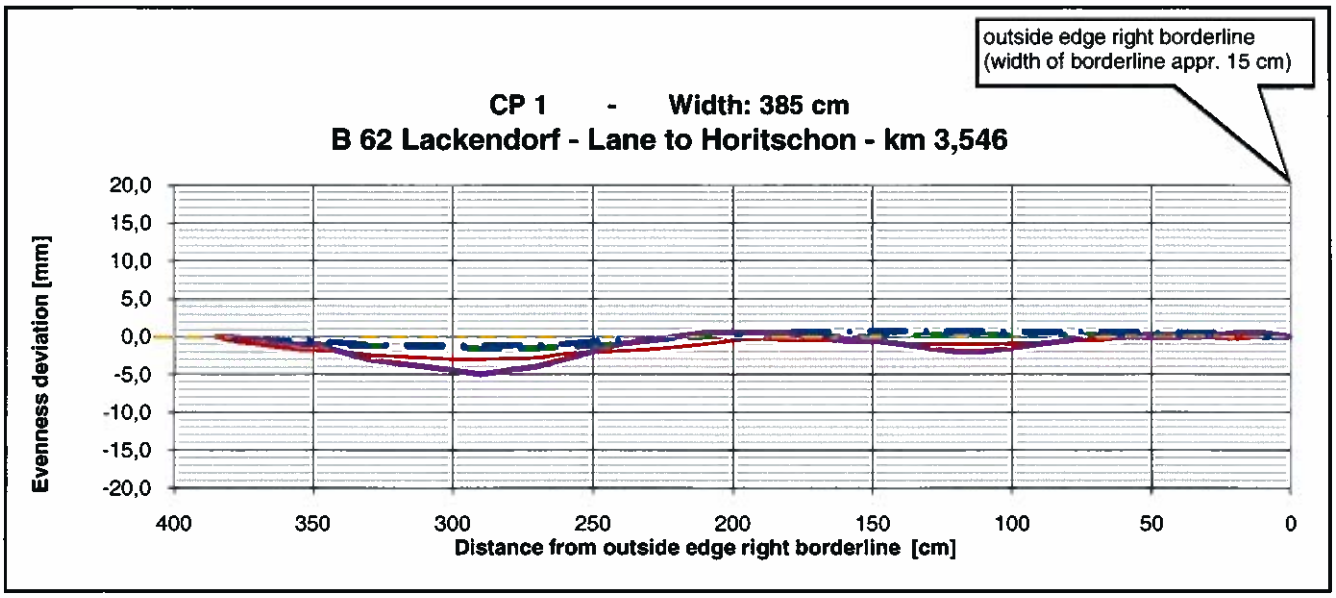
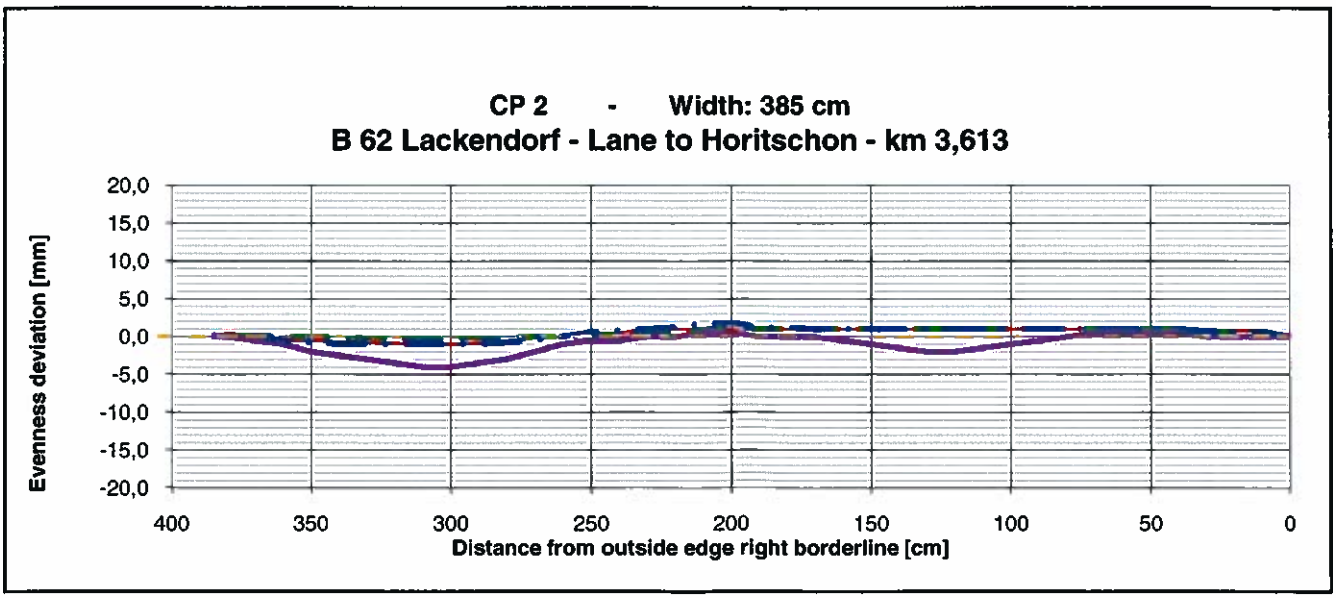
Asphalt modified with hydrated lime





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Nievelt Labor GmbH
Akkreditierte Prüf- u. Überwachungsstelle
A-2000 Stockerau Wiener Straße 35
Tel.: +43-(0)2266-64110 Fax +43-(0)2266-65897

NIEVELT Labor GmbH

Prüf- und Inspektionsstelle für Baustoffe • Akkreditiert durch das BMWA und durch das OIB

office@nievelt.at

A-2000 Stockerau Wiener Straße 35 T: +43-(0)2266-64110 F: +43-(0)2266-65897
A-6060 Hall in Tirol Lorettostraße 26 T: +43-(0)5223-42106 F: +43-(0)5223-42173

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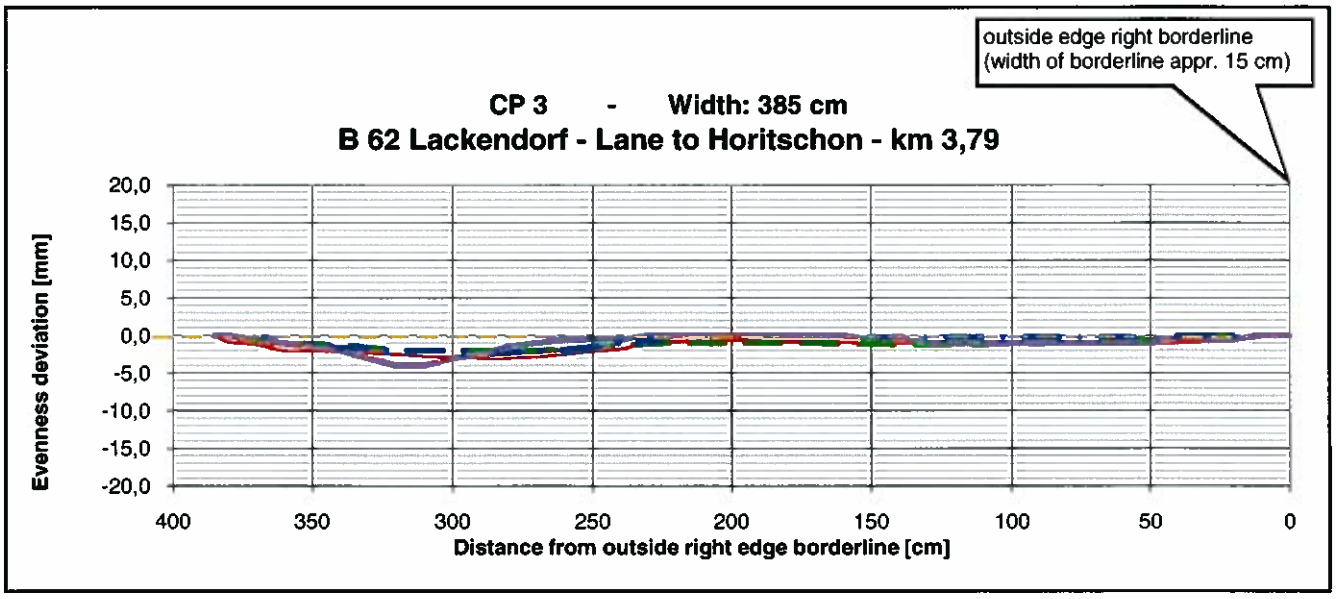
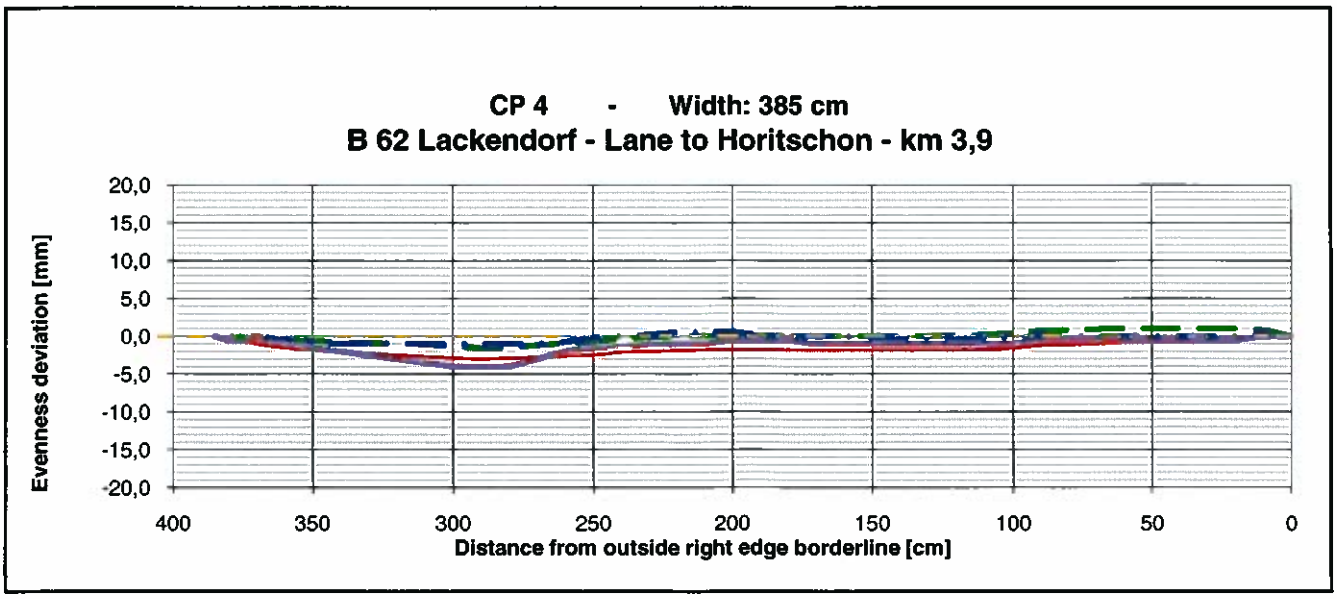
Asphalt with polymer-modified bitumen





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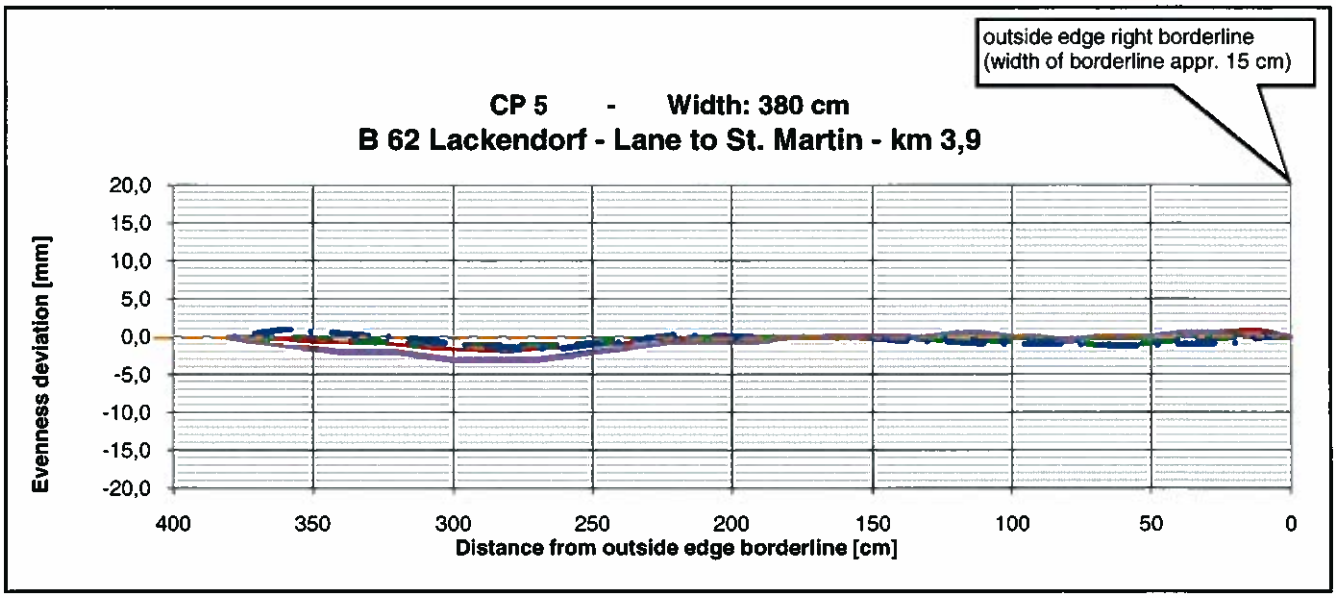

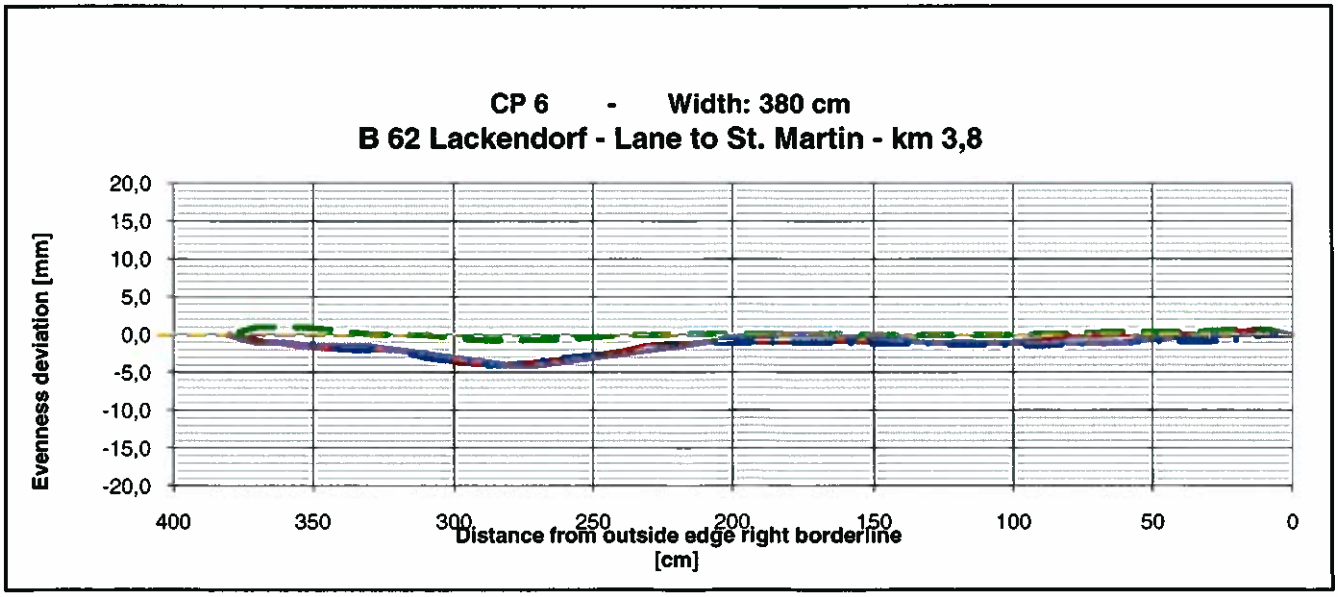

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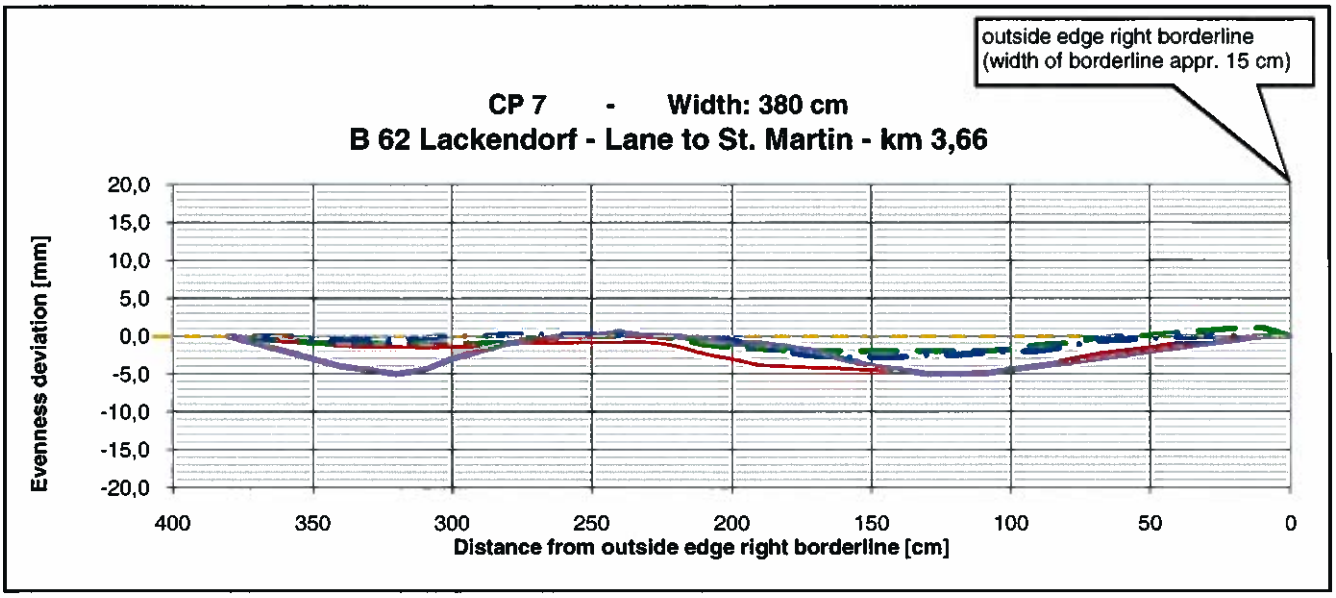

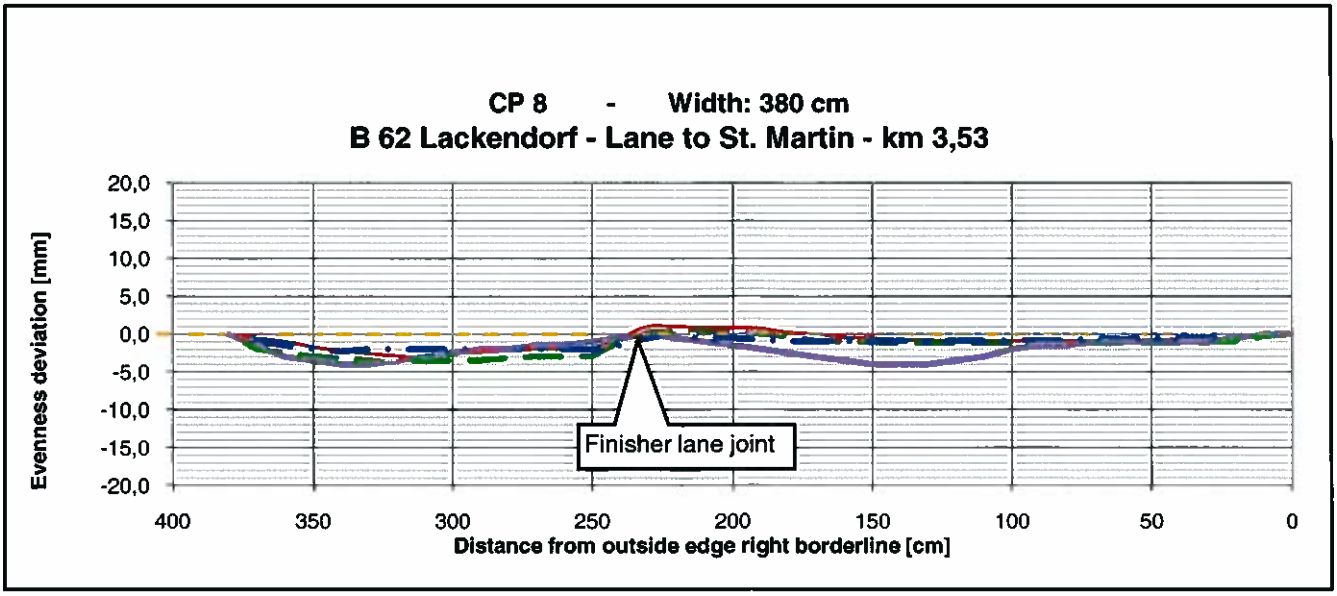

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