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LINTRACK research into expansion joint behaviour

Silent Joint 500 Resa S test results

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1. INTRODUCTION

By quotation request with identification MII/081925 the Ministry of Transport, Public Works and Water Management, Directorate-General for Public Works and Water Management, Centre for Transport and Navigation (DVS) invited the Delft University of Technology to submit an offer for execution of LINTRACK research into the performance of five silent expansion joint systems for concrete bridges. The University submitted her offer with identification MH 29/08/08 on August 29 2008. September 15 2008 the DVS accepted the offer and contracted the University to execute the research by assignment with identification 31010232.

The research aims to subject expansion joint systems to loadings that closely resemble the loadings that these systems experience in real bridges. The expansion joints in this research are all bituminous; because of the risk of rutting it was therefore chosen to test at elevated temperatures. A test setup including full scale bridge sections was constructed. This setup is and the test protocol is extensively discussed elsewhere; *Huurman M. & Moraal J., LINTRACK research into expansion joint behaviour, Test setup, protocol and measurement plan, report 7-08-202-2, September 2009.*
The LINTRACK test is part of the DVS contest "Silent Durable Joints" (www.rijkswaterstraat.nl/ipw). The research concentrates on the four best innovative joint systems. A reference joint system is also involved.

1	Reference joint system:	Multi-joint (Smits Neuchatel)
2	Innovative joint system #1:	Prefab Silent Joint (Salverda)
3	Innovative joint system #2:	KLK Joint (Van Kessel, Latexfalt & Kraton)
4	Innovative joint system #3:	Brain Joint (Heijmans)
5	Innovative joint system #4:	Prismo Joint (Prismo)

The goal of the research is to rank the performance of four innovative joint systems, i.e. the latter joint systems in the above list. The reference joint system, i.e. the first in the above list, is applied frequently in the Netherlands. From practise it is known that asphaltic plug joints, such as the reference joint system, have an average service life of approximately 3 years. The reference joint is incorporated in the research to serve as a bench mark.

Test results for the five joint systems are reported in five separate reports.

Hereafter the LINTRACK performance test on the Multi-joint is discussed. First the Multi-joint is described in Chapter 2. Thereafter Chapter 3 discusses the construction of two the Multi-joints in the LINTRACK facility. Chapter 4 is the main body of this report and discusses the results of the accelerated joint test. Similarly Chapter 5 discusses static tension test results. Finally in Chapter 6 conclusions and recommendations are listed.

2. DESCRIBTION OF THE PREFAB SILENT JOINT

The Prefab Silent Joint system basically consists of two steel profiles placed parallel to each other. Between the two profiles springs are installed. The profiles act as a framing and allow prefab installation of a bituminous joint body that buries the springs. The joint body consists of a course single sized mineral skeleton in which a bituminous binder is worked in.

Figure 1. Left: Prefab Silent Joint element at contractors yard. Right: prefab element anchored to concrete substrate at LINTYRACK site.

The Prefab Silent Joint is installed in a cut or milled trough and anchored to the substrate. Hereafter the prefab element is buried using a mixture of single sized stones and worked in binder. Finally the surface is provided with small size chippings to provide a joint surface with ample resistance. Figure 2 gives a schematic cross section of the completed Prefab Silent Joint system. In the LINTRACK test the Prefab Silent Joint 500 Resa S was tested. This joint has a net distance between the parallel profiles of 500 mm.

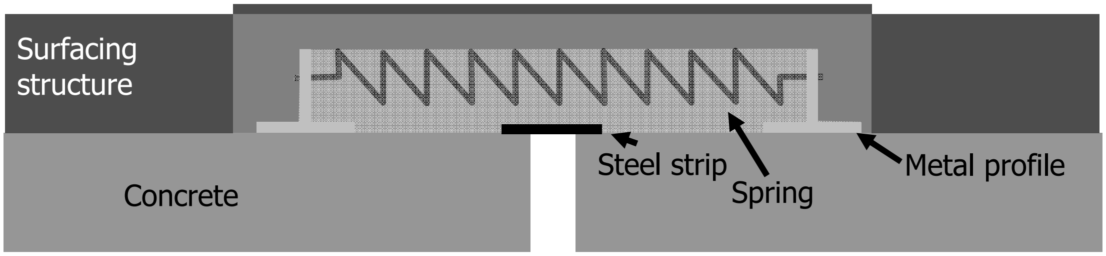


Figure 2. Cross section of the Prefab Silent Joint system (not to scale).

For further information about the Prefab Silent Joint system reference is made to Appendix A.

3. JOINT SYSTEM INSTALLATION

Reference is made to Appendix B where a photo report of the Prefab Silent Joint installation can be found. Here the most important installation issues are discussed.

The in situ thickness of the surfacing structure on the concrete bridge decks and the bridge end support is approximately 110 mm. A concrete repair mortar was used to ensure that the prefab element would be installed on a levelled surface. Application of the repair mortar also gives control over the joint construction height.
Before installing the prefab element a metal strip is installed to bridge the actial joint. This strip is held in place by application of bituminous binder. Anchoring of the prefab element is given ample attention. A soft bedding material is applied to ensure that the outer edges of the metal profiles make good contact with the substrate.
After installation of the prefab element the two outer springs of the joint system are installed. Hereafter the trough that now contains the prefab element is filled with bituminous joint material to level the surface of the prefab element.
After cooling the complete system is buried with bituminous joint material. During construction of this final layer attention is given to obtaining a properly levelled joint. Hereto the heated single sized aggregates are worked into the trough and levelled by hand. Only when the skeleton surface is properly levelled the bituminous binder is worked in.
Finally small size chippings are applied to obtain a good looking surface with ample skid resistance.

Figure 3 gives an impression of the finished Prefab Silent Joint systems in the LINTRACK test facility.

Figure 3. View on the two Prefab Silent Joint systems installed in the LINTRACK facility before trafficking. Left: closed joint, referred to as joint -13 mm. Right: opened joint, referred to as joint +13 mm.

4. ACCELERATED JOINT TEST RESULTS

4.1 Introduction

Reference is made to (1) for an elaborate description of the test setup, the test protocol and the measurement plan.

4.1.1 Pre stressing the joint system

The test protocol demands that joints systems are installed with a 50 mm spacing separating the bridge decks and the central bridge end support. Before further testing one joint is opened to +13 mm, while the other is closed to -13 mm. These deformations are to be applied without damaging the joint system. For this reason the protocol prescribes that joint pre stressing should take place at 30°C. Displacement rates should not exceed 10 mm/hour.

Closing of the -13 mm joint did not result in any visible damage.
After opening of the +13 mm joint a small surface defect appeared. The defect was hardly visible and appeared to be a non continuous crack in the surface treatment. During trafficking the defect became more visible without growing or progressing.
The defect was located over a thermo couple that was installed into the joint system after its completion and before its opening. Installation of the thermo couple required the drilling of a small horizontal drill hole approximately 15 mm below the joint surface.
Figure 4 gives an impression of the described defect.

Figure 4. Surface defect in +13 mm joint before trafficking (left) and at the end of trafficking (right).

4.1.2 Completed loadings

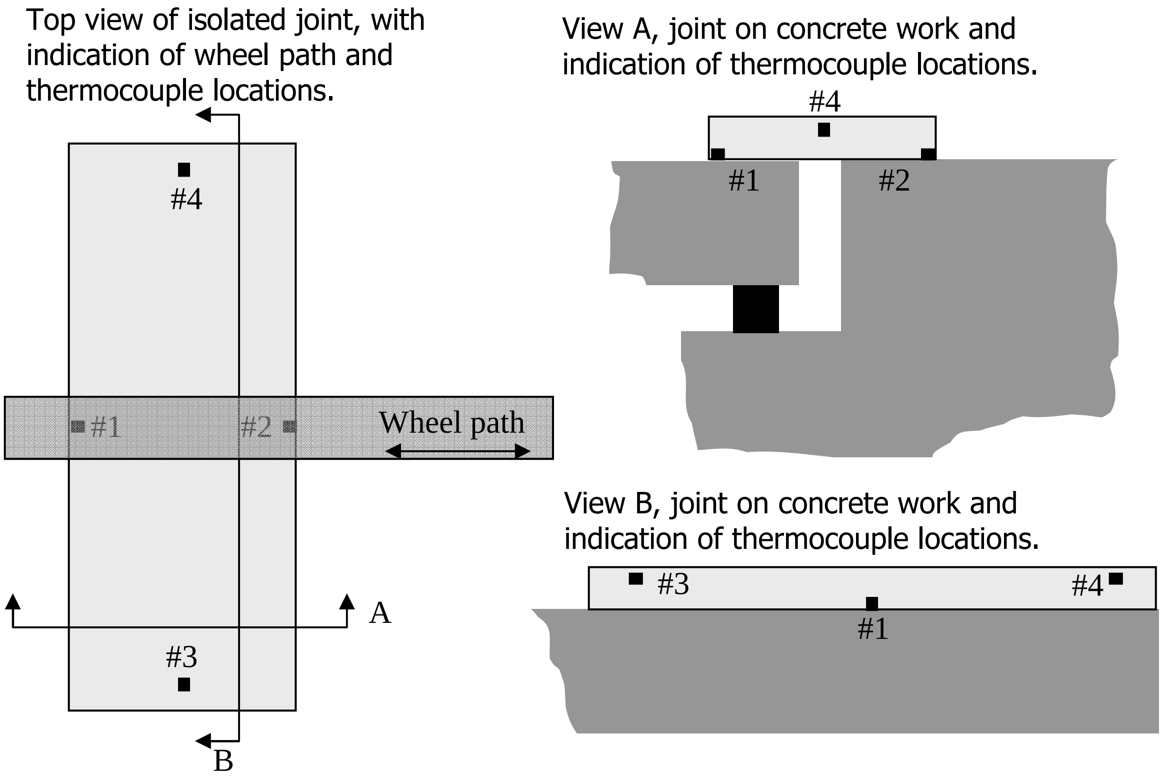
Testing of the Prefab Silent Joint system came to an end after completion of 85,000 load repetitions following the protocol summarised in Table 1. The reason for stopping the test before completion of the protocol was not related to the performance of the joint system. The reason for ending the test was the development of depressions in the surfacing structure of the bridge deck just adjacent of the joints, see section 4.4.2. These depressions caused undesired dynamics that became a threat for the LINTRACK test facility.

Table 1. Summarised protocol.

	Number of load repetitions				
	0-20000	20001-40000	40001-60000	60001-80000	80001-100000
Wheel load	3.5 tonnes	4.5 tonnes	4.5 tonnes	5.5 tonnes	5.5 tonnes
Temperature	30°C	30°C	35°C	35°C	40°C

4.2 Joint temperatures

For registration of the joint temperature four thermo couples are installed in each of the tested joints, see Figure 5. Two thermo couples register the temperature at the bottom of the joint under the wheel path. These couples (#1 and #2) are installed at the interface between repaired concrete substrate and the joint body. At the outer edges of the joint body thermo couples are installed approximately 15 mm below the surface (#3 and #4). These latter thermo couples are located approximately 100 mm into the joint body.


Top view of isolated joint, with indication of wheel path and thermocouple locations.

View A, joint on concrete work and indication of thermocouple locations.

View B, joint on concrete work and indication of thermocouple locations.

Figure 5. Location of four thermocouples that register joint system temperature.

From the registered temperatures the joint surface temperature and the joint bottom temperature is determined. From these values the average joint temperature and the difference between the surface and bottom temperature is determined. Registered values are listed in table 2.

Table 2. Registered Joint temperatures (standard deviation between brackets).

		Wheel load repetitions [-]		
		0-40,000	40,001-80,000	80,001-100,000
-13 mm joint system	$T_{surface}$ [°C]	30,1 (0,6)	34,3 (1,9)	40,0 (0,6)
	T_{bottum} [°C]	30,6 (1,2)	37,6 (1,9	43,1 (1,7)
	T_{joint} [°C]	30,4 (0,8)	36,0 (1,5)	41,6 (1,0)
	$T_{surface}$- T_{bottum} [°C]	-0,5 (1,0)	-3,4 (2,5)	-3,1 (1,5)
+13 mm joint system	$T_{surface}$ [°C]	30,4 (0,8)	34,2 (2,4)	40,7 (0,8)
	T_{bottum} [°C]	30,4 (1,3)	36,7 (1,5)	43,7 (1,3)
	T_{joint} [°C]	30,4 (1,0)	35,4 (1,6)	42,2 (1,0)
	$T_{surface}$- T_{bottum} [°C]	0,0 (1,0)	-2,5 (2,2)	-3,0 (1,0)

Where; $T_{surface}$: temperature at joint edges 15 mm below the pavement surface [°C]; T_{bottum}: temperature at the bottom of the joint system in the wheel path [°C]; T_{joint}: Joint temperature, i.e. average of four thermocouples [°C].

Registered temperatures indicate limited temperature variations with time. Reported values are average values.

4.3 Joint movements

The movements of the bridge decks under wheel loadings are monitored using a total of 7 LIPS (Linear Inductive Position Sensor) per bridge deck. A graphic impression of their location is given in Figure 6.

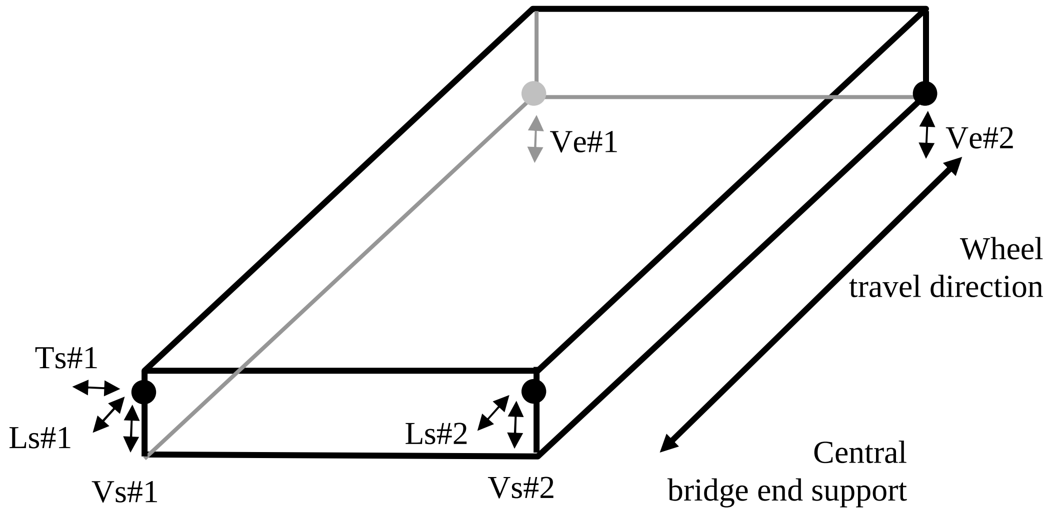


Figure 6. Movements of the bridge decks are monitored by 7 LIPS.

In principal the bridge deck and thus the joint between bridge and central bridge end support has 6 degrees of freedom, i.e. Lateral, transversal and vertical translation and rotation about the lateral, transversal and vertical axes. This implies that 6 LIPS give all information required to reconstruct joint movements. However, to ensure proper measurement of the joint movements it was decided to use more sensor than required. To make optimum use of these sensors and to limit uncontrolled lateral movements of the bridge deck sliders that restrain lateral movement of the bridge sections were installed.

Due to the nature of the bridge deck and the effects of the installed slider only three types of joint deformations of magnitude occurred in each individual joint system test.

1 Vertical movements

When the bridge deck is pushed down as a result of the overhead wheel load the joint system sitting between the bridge and the bridge end support is subjected to a vertical movement. See Figure 7 for visual explanation.

2 Rotation about transversal axis

Vertical deformations are largest at the bridge end support. As a result vertical deformations cause rotations about the transversal axis. See Figure 7 for visual explanation.

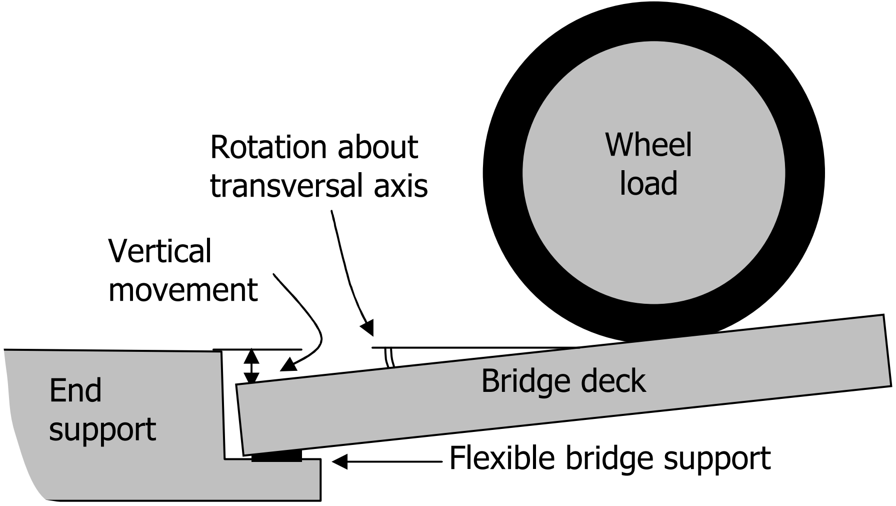


Figure 7. Visual explanation of vertical deformation and resulting rotations about the transversal axis.

3 Translation about longitudinal axis

Wheel loads are travelling the 3 m wide bridge decks at ¼ - ¾ of the deck width. As a result minor rotations about the longitudinal axis may develop. See Figure 8 for a visual explanation.

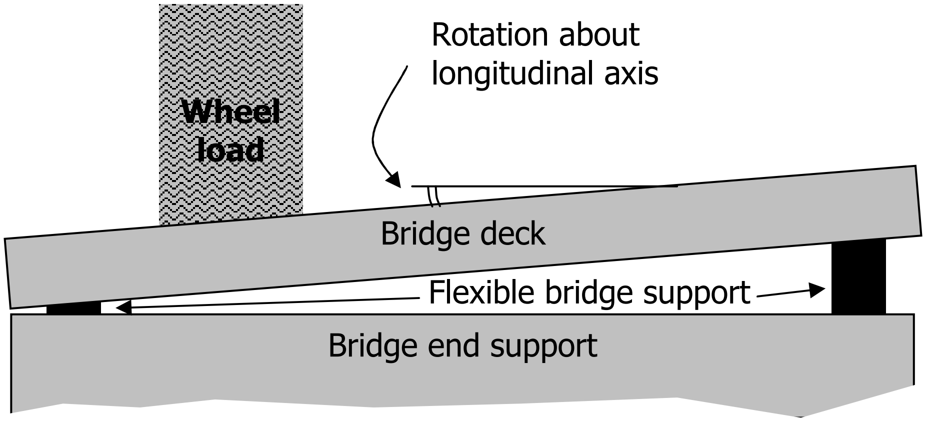


Figure 8. Visual explanation of rotation about the longitudinal axis resulting in joint deformations.

The following joint deformations were registered at the centre of the joint system, i.e. mid height at the centre of the wheel path. The figures give the joint deformation as a function of the longitudinal wheel position. In figures 9 and 10 the central bridge end support is clearly reflected in the centre of the plots as joint deformations remain negligible when the wheel is travelling on the central support.

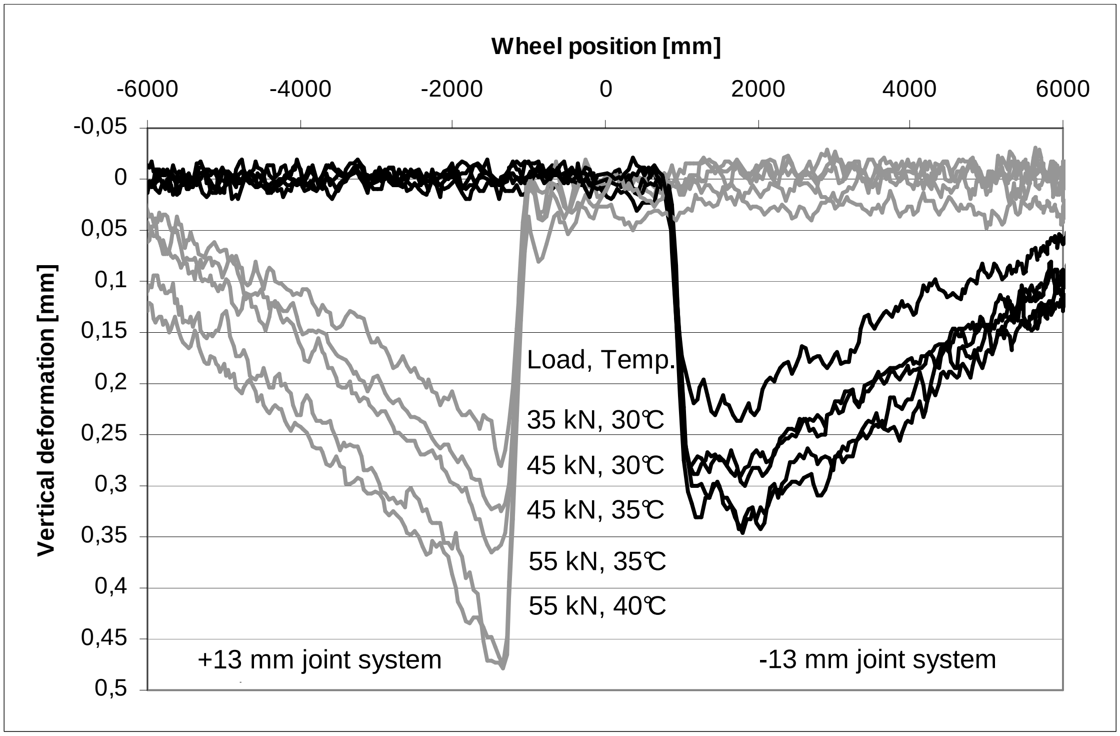


Figure 9. Registered vertical joint deformation for three steps of the protocol.

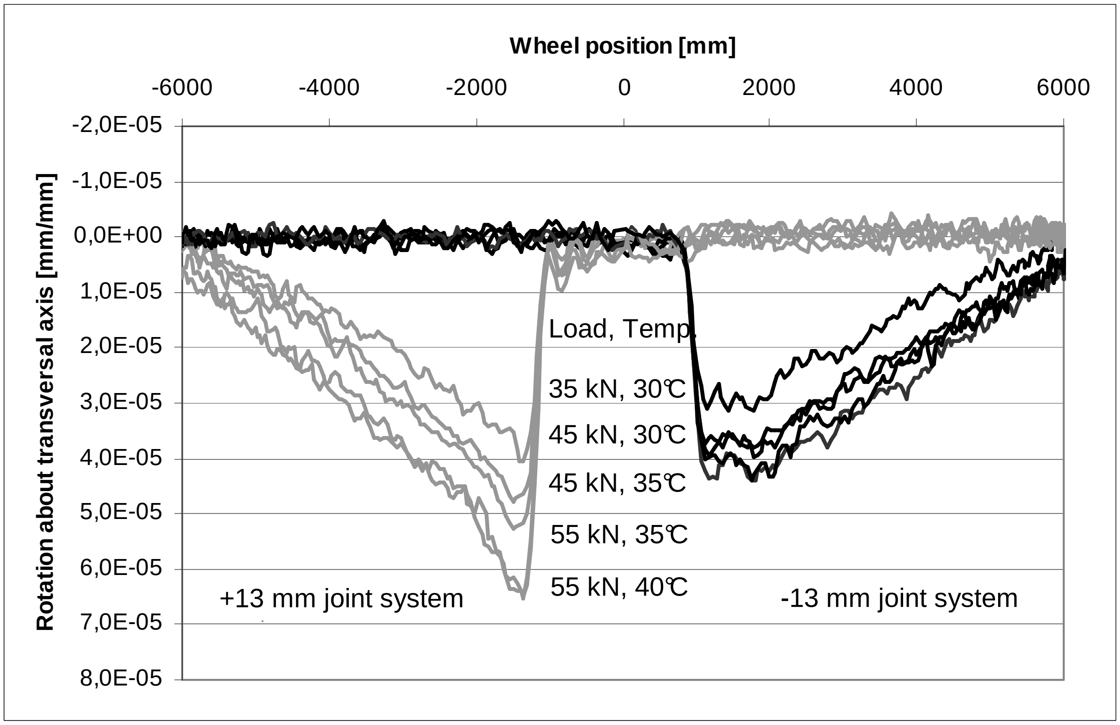


Figure 10. Registered rotation about the transversal axis for three steps of the protocol.

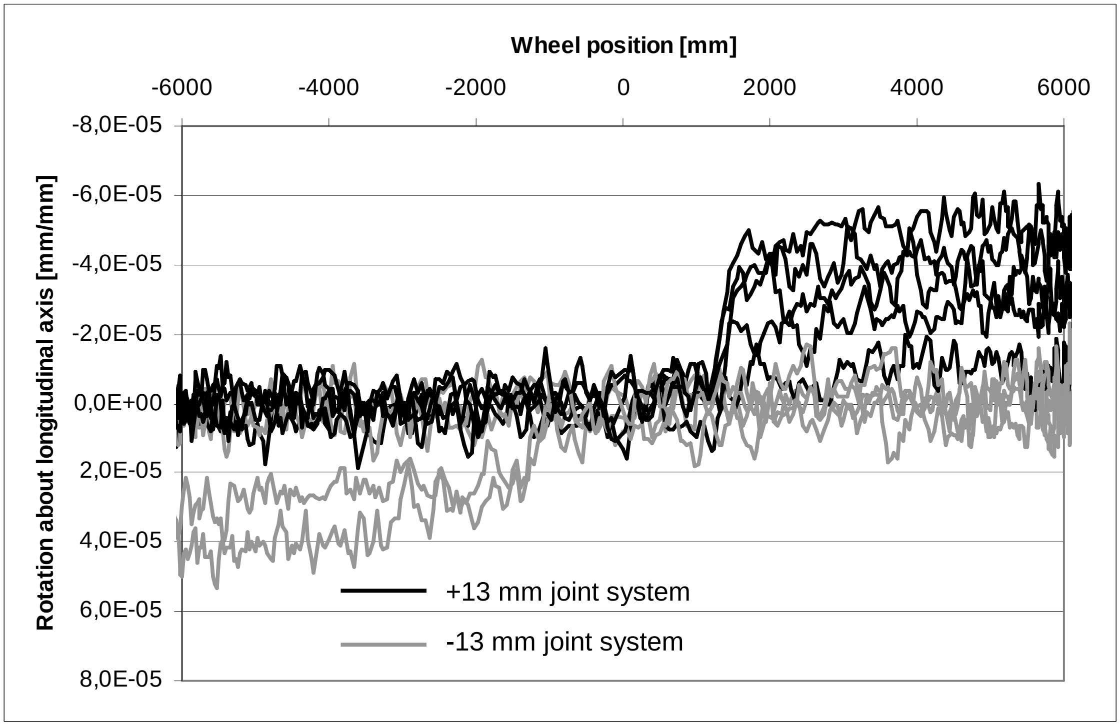


Figure 11. Registered rotation about the longitudinal axis for three steps of the protocol.

Table 3 gives a summary of obtained results.

Table 3. Registered maximum joint movements.

		35 kN, 30°C	45 kN, 30°C	45 kN, 35°C	55 kN, 35°C	55 kN, 40°C
-13 mm joint system	U_{vert} [mm]	0,24	0,29	0,30	0,35	0,34
	R_{trans} [mm/mm]	3,1E-5	3,8E-5	4,0E-5	4,4E-5	4,4E-5
	R_{long} [mm/mm]	1,8E-5	9,5E-6	1,1E-5	1,5E-5	1,2E-4
+13 mm joint system	U_{vert} [mm]	0,28	0,33	0,37	0,48	0,47
	R_{trans} [mm/mm]	4,1E-5	4,8E-5	5,3E-5	6,5E-5	6,5E-5
	R_{long} [mm/mm]	-1,4E-5	-1,3E-5	-5,3E-6	-2,1E-6	-2,3E-5

From the previous it is learned that joint deformations are dependant on wheel load magnitude. The temperature susceptibility of the joint deformations is limited.

It is known that the vertical deformations in absence of a joint system are approximately 0.01mm/kN at ambient temperatures. In combination with Table 3 this indicates that the Prefab Joint System significantly reduces vertical joint movements to approximately 0.007 mm/kN on average. From this it is concluded that the Prefab Silent Joint system adds stiffness to the joint area.

The registered vertical joint movements and joint rotations about the transversal axis show a clear trend with both temperature and load magnitude. Registered rotations about the longitudinal axis, however do not show this clear trend. Here the measurements appear noisier. However, it can be observed small rotations about the longitudinal axis are present during period that the wheel travels a bridge deck.

4.4 Surface deformation

A profilometer was applied to measure the transversal profiles at the centre of each tested joint. Also the longitudinal profiles in the wheel path centre were registered. In the sections hereafter results are reported.

4.4.1 Transversal unevenness and Rutting

Figure 12 gives an impression of the development of the transversal profile of the -13 mm joint system. Similarly Figure 13 gives an impression of the development of the relative transversal profile in that joint system.

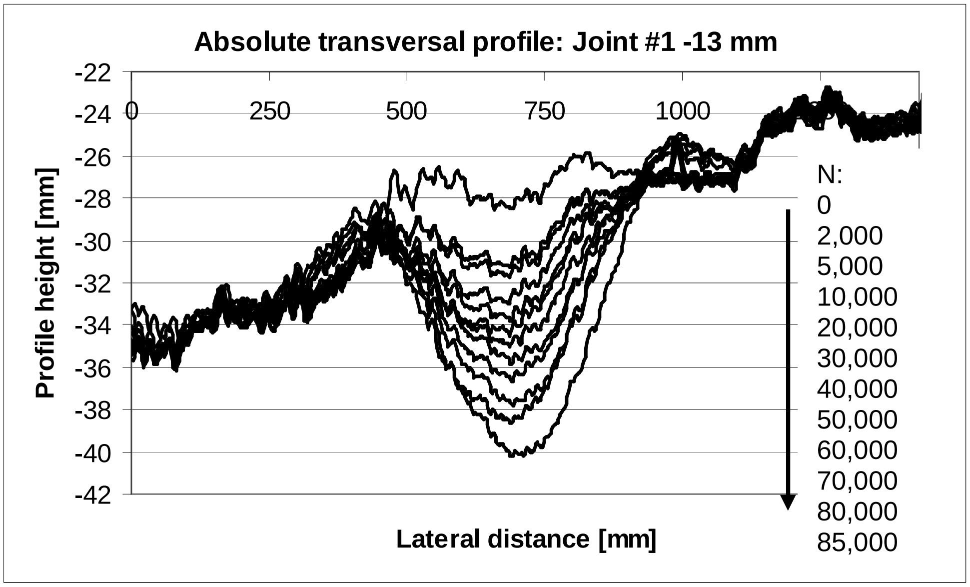


Figure 12. Absolute transversal profile of -13 mm joint system.

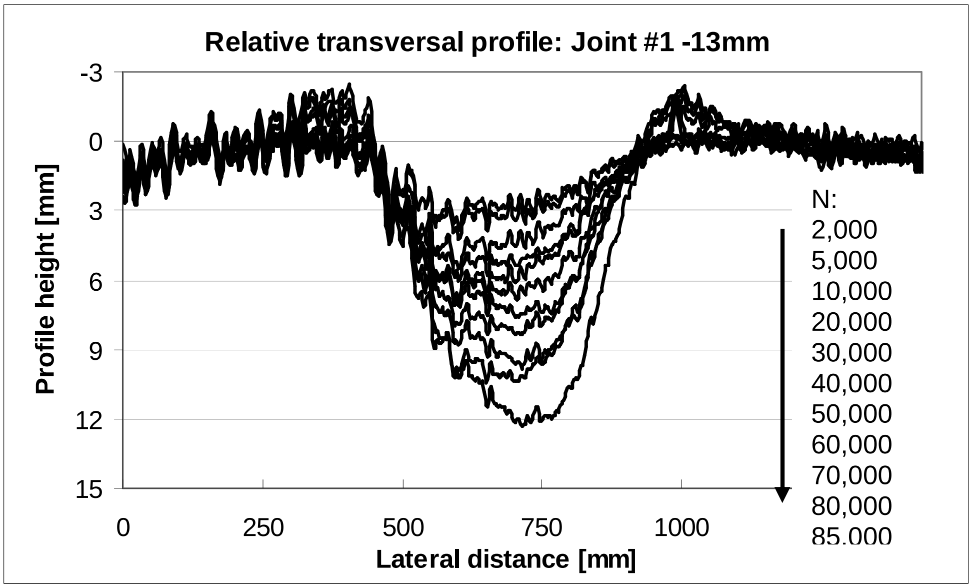


Figure 13. Relative transversal profile of -13 mm joint system.

Similarly Figures 14 and 15 give insight into the development of transversal unevenness in the +13 mm joint system.

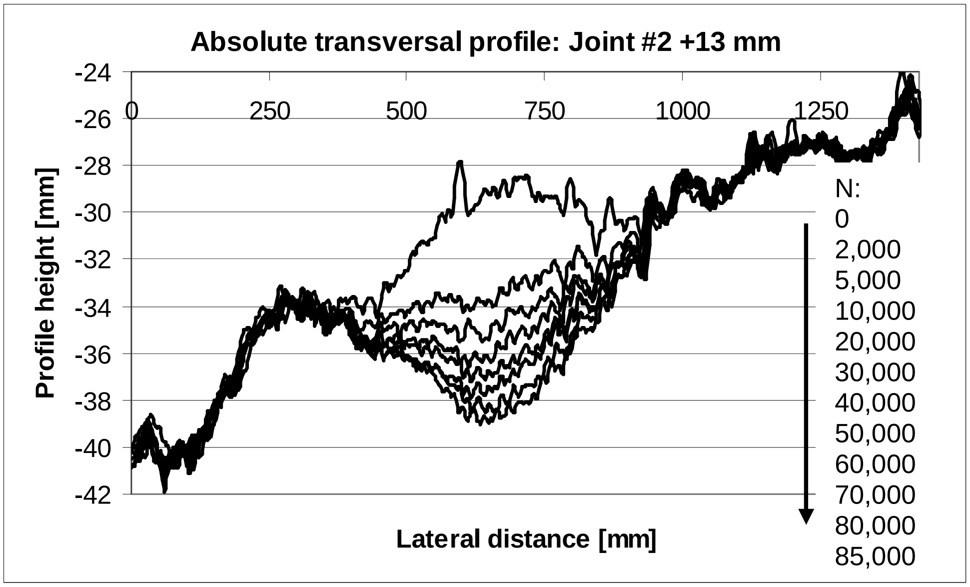


Figure 14. Absolute transversal profile of +13 mm joint system.

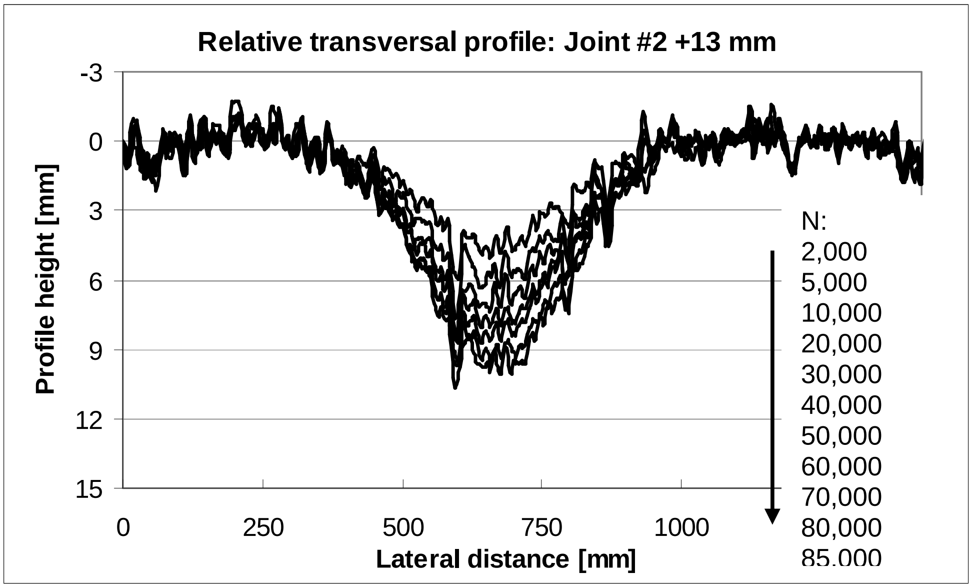


Figure 15. Relative transversal profile of +13 mm joint system.

It is stated that an absolute transversal profile is the transversal profile as measured against a levelled straight rule. A relative transversal profile gives the differences between the initial profile and subsequent transversal profiles. As such the relative transversal profiles are much more relevant and give an indication of true joint system rutting behaviour.

From the discussed transversal profiles the rut development in the joint system may be derived. The absolute rut depth is defined as the absolute lowering of the joint surface in the deepest point of the registered rut. The relative rut depth gives the maximum difference between an imaginary straight rule and the joint surface, see Figure 16. Figures 17 and 18 give obtained rutting results.

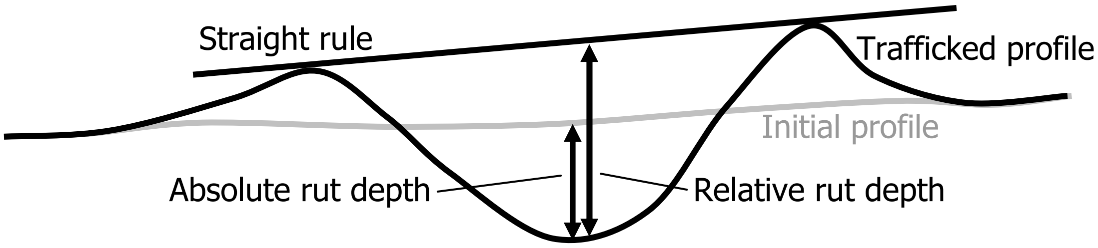


Figure 16. Definition of absolute and relative rut depth.

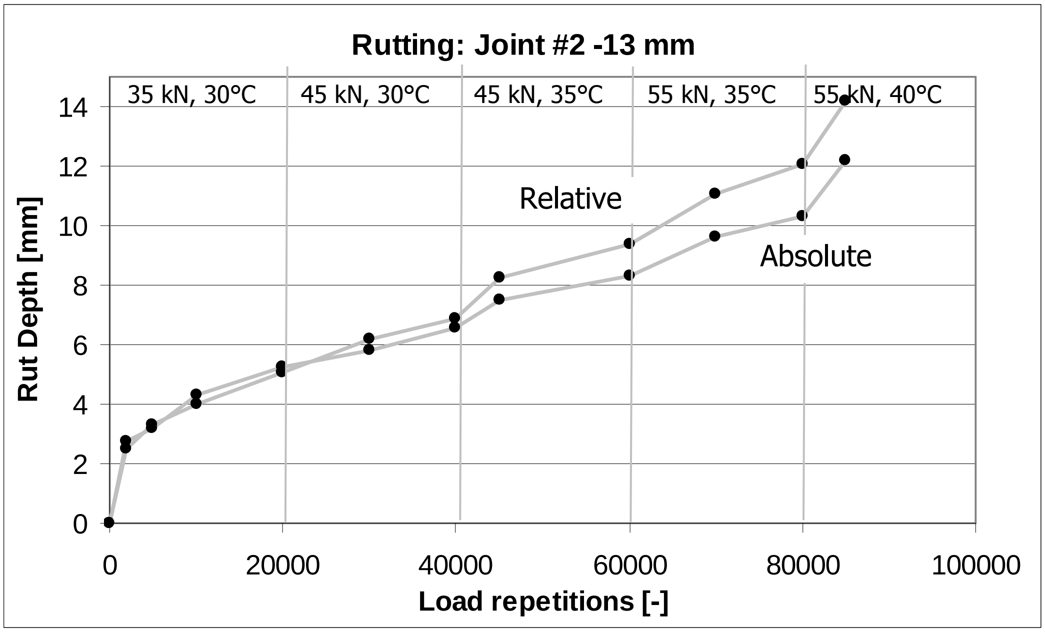


Figure 17. Rutting in the -13 mm joint system.

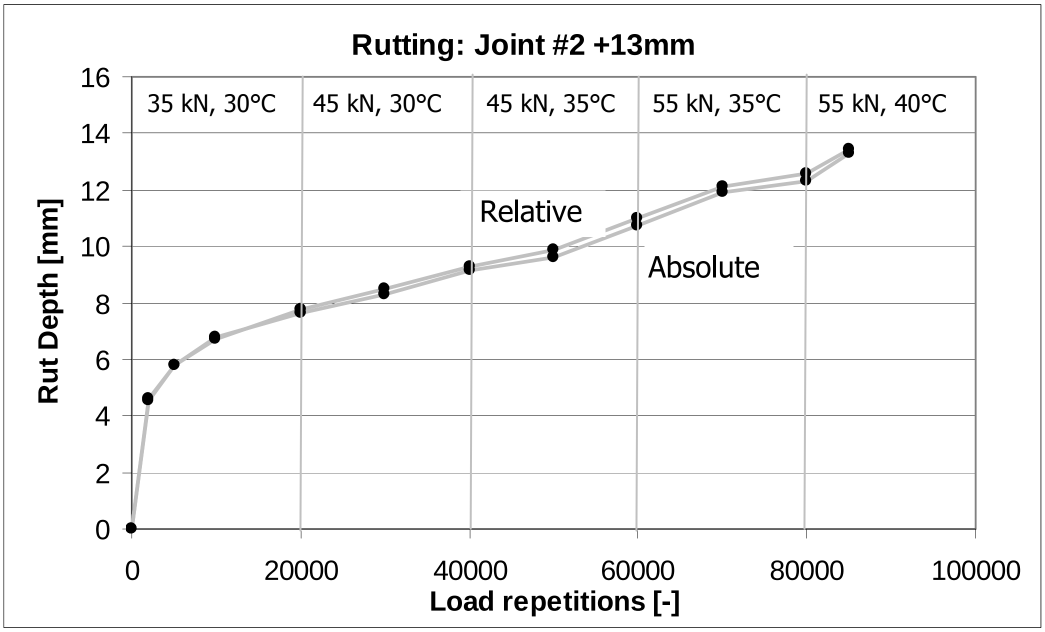


Figure 18. Rutting in the +13 mm joint system.

Table 4. Summarised rutting results for the Multi-joint system.

	-13 mm system		+13 mm system	
N [-]	Relative [mm]	Absolute [mm]	Relative [mm]	Absolute [mm]
2000	2,5	2,8	4,6	4,6
5000	3,3	3,2	5,8	5,8
10000	4,0	4,3	6,7	6,8
20000	5,1	5,2	7,8	7,6
30000	6,2	5,8	8,5	8,3
40000	6,9	6,6	9,3	9,2
50000	8,2	7,5	9,9	9,6
60000	9,4	8,3	11,0	10,7
70000	11,1	9,6	12,1	11,9
80000	12,0	10,3	12,6	12,3
85000	14,2	12,2	13,4	13,3

Rutting in the -13 mm joint is a result of the development of a depression in the centre of the wheel path which is flanked by small up heaves directly adjacent to the wheel path. This is clearly indicated by Figures 13 and reflected in figure 17 which shows a larger difference between the relative and absolute rut depth. In the +13 mm joint the development of small up heaves is negligible so that the difference between absolute and relative rut depth remains very limited, see Figure 18.

It is also observed that the absolute rut depth in the -13 mm joint develops at a slightly lower rate than in the +13 mm joint. Due to the observed development of up heaves the opposite is true for relative rut development.

Many researchers distinct between rutting due to traffic compaction and rutting due to shear deformation. The first type of rutting is related to the quality of construction, i.e. pre compaction, and does not result in up heaves. The second type of rutting is related to structural stability and does result in up heaves. On the basis of this one could argue that the -13 mm joint is slightly less stable than the +13 mm joint. This may also explain the larger temperature susceptibility of the -13 mm joint which, contrary to the +13 mm joint, clearly shows stepped rutting curves. Steps are located at N=40,000 and N=80,000 when the joint temperature is increased with 5°C.

4.4.2 Longitudinal unevenness

Figure 19 gives an impression of the development of the longitudinal profile in the centre of the wheel path. In the longitudinal profile the two tested joint systems are clearly visible as their surface is approximately 4 to 5 mm above the surface of the adjacent surfacing structure.

Figure 19 also indicates that rutting in the bridge surfacing structure develops much faster than in the Prefab Silent Joint system. Especially when the temperature reaches 40°C rut development in the bridge surfacing structure progresses at high rate.

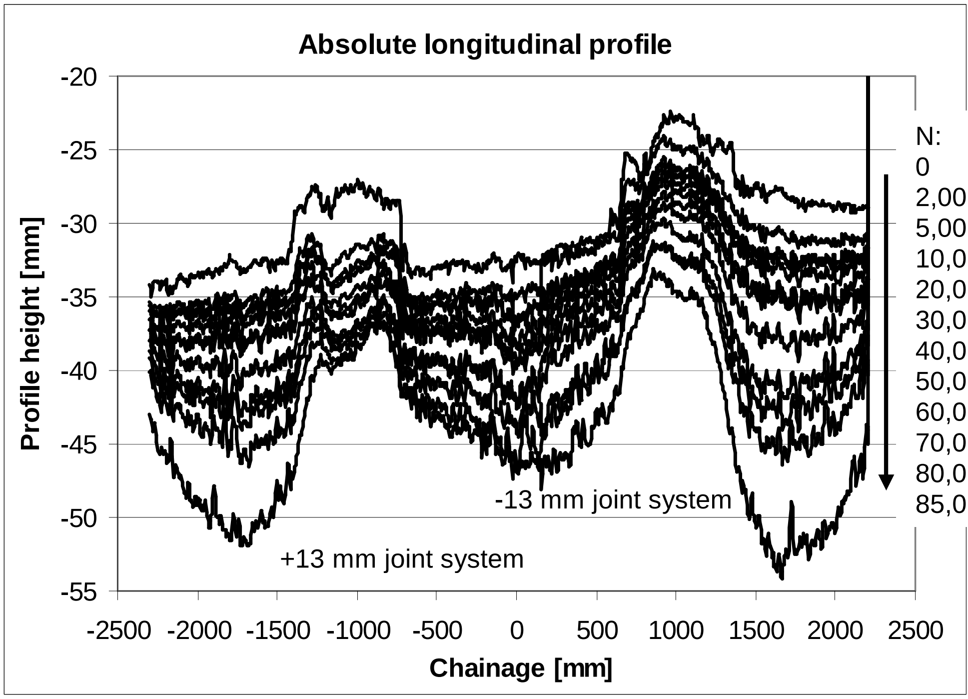


Figure 19. Development of the longitudinal profile.

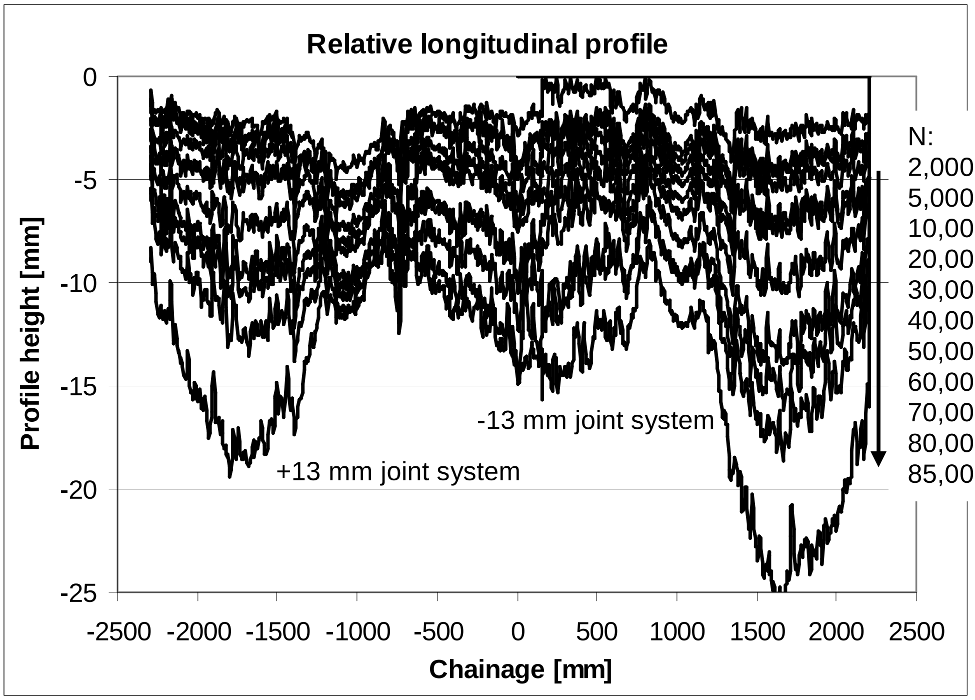


Figure 20. Development of the relative longitudinal profile.

Figure 20 gives the development of the relative longitudinal profile. In this figure the joints are not easily recognised since they do not appear as plateaus but much more as smoothed peaks. Similarly the depressions in the adjacent surfacing structure appear smoothed, again a step function is not recognised.

The previous indicates the tendency of the system to maintain a smooth longitudinal profile. It is not known which phenomenon causes this behaviour. There are three possible explanations.

- The bridge deck surfacing structure and the Prefab Silent Joint system structurally affect each other,
- It is a result of the smoothening effect of moving tyres,
- The temperature distribution is not homogeneous.

4.5 Observations & visual inspections

As discussed in the previous section rutting developed in the Prefab Silent Joint system. Figure 21 gives a visual impression of rutting at the end of the test.

Furthermore a defect developed while opening the +13 mm joint. This defect was hardly visible at the start of trafficking. During trafficking the defect became pronounced without growing or progressing, also see Figure 4.

Apart from the above mentioned observations no other damage developed in the Silent Joint system during trafficking, see Figure 22. Reference is made to Appendix C where more photographs made during visual inspections are found.

Figure 21. Rutting in the Prefab Silent Joint after 85,000 load repetitions. Left: +13 mm joint, right: -13 mm joint. (also see Appendix C)

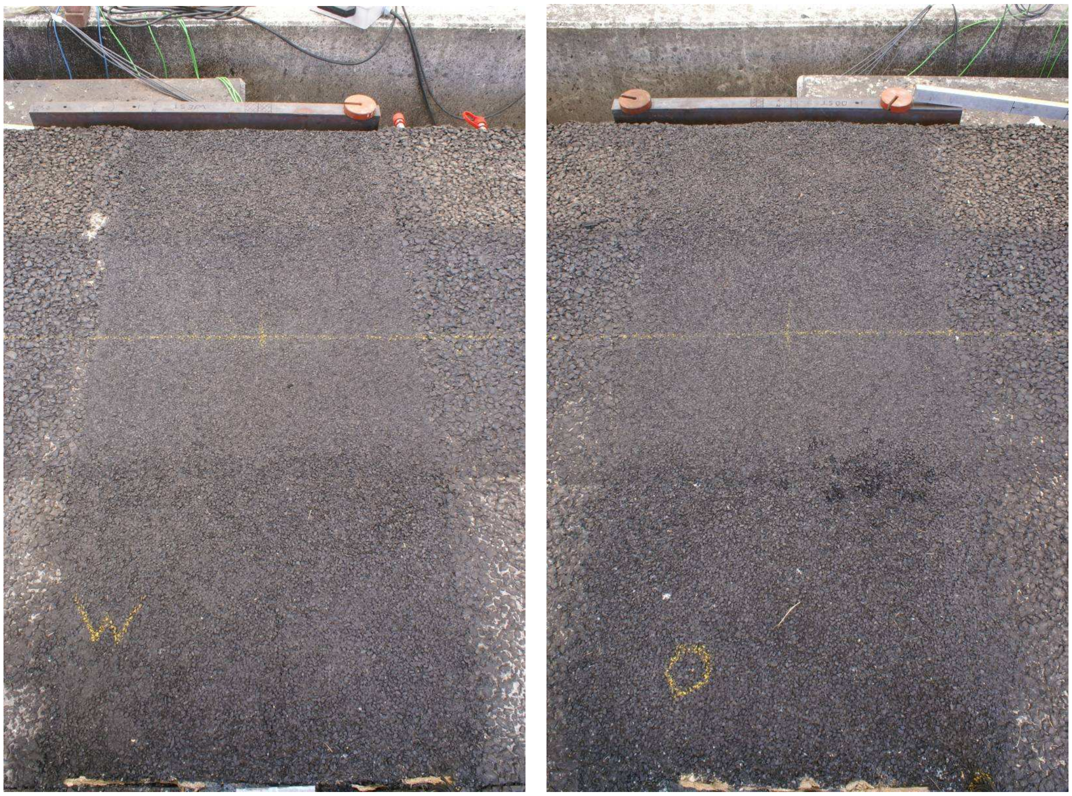


Figure 22. Status of the tested joints after application of 85,000 load cycles. Left: +13 mm joint, right: -13 mm joint. (also see Appendix C)

4.6 Additional measurements

Measurements that are beyond the scope of the research contract were performed while testing the Prefab Silent Joint system. These are transversal profile measurements in the middle of the central bridge end support. These measurements were started after application of 10,000 load cycles implying that the initial transversal profile is not known. As a result of that the measurements give insight into the development of the absolute transversal profile. From this profile only the development of the relative rut depth can be obtained. Results are found in Figures 23 and 24. Results are listed in Table 5.

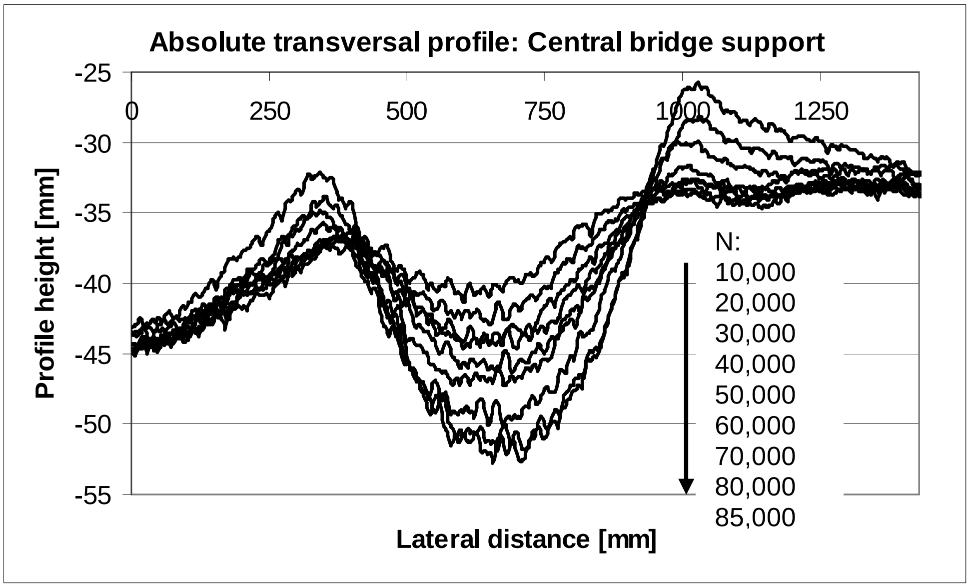


Figure 23. The development of the absolute transversal profile in the middle of the central bridge end support.

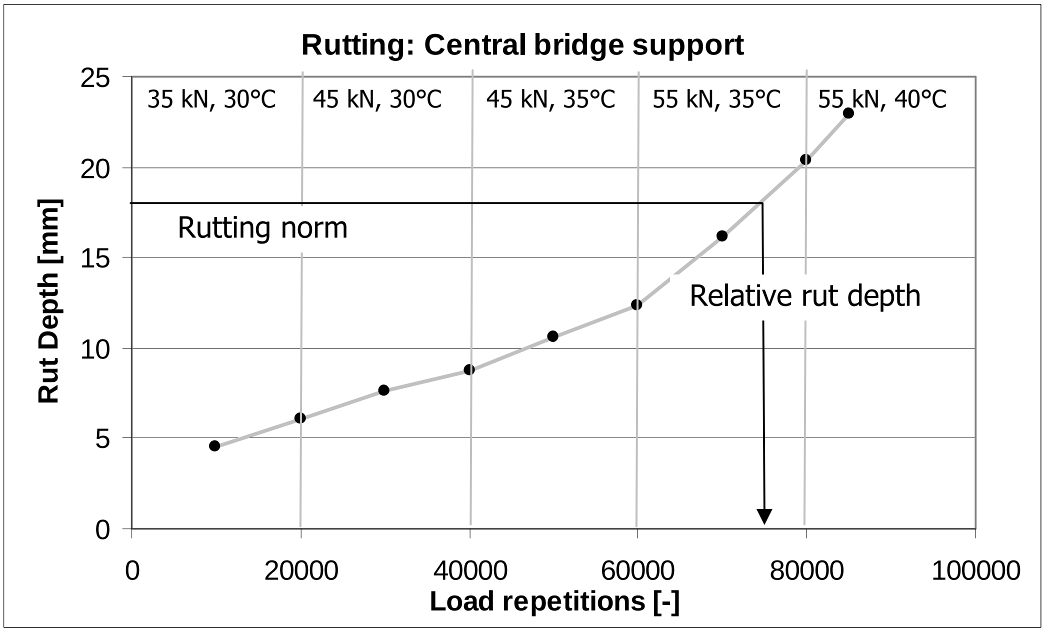


Figure 24. Absolute rut development at the middle of the central bridge end support.

Table 5. Summarised rutting results for the bridge deck surfacing structure at the centre of the central bridge deck support.

N [-]	Relative [mm]
10000	4,6
20000	6,0
30000	7,6
40000	8,8
50000	10,6
60000	12,3
70000	16,2
80000	20,4
85000	23,0

In combination with the profile measurements discussed in section 4.4. the above clearly indicate that the Silent Joint System outperforms the bridge deck surfacing structure with respect to rutting.

In figure 24 an indication of the 18 mm rutting norm is given. It is indicated that the bridge deck surfacing structure at the central bridge support has a rutting life of approximately 74000 load repetitions following the prescribed protocol. Rutting in the Prefab Silent Joint did not exceed approximately 14 mm after completion of 85,000 repetitions.

5. TENSION TESTS

Semi static tension tests were performed on the Prefab Silent Joints after completion of the discussed LINTRACK accelerated pavement. The static tension tests were performed at 25°C. The -13 mm joint was opened at a rate of 10 mm/hour; similarly the +13 mm joint was further opened at a rate of 100 mm/ hour.
Figures 25 and 26 give the results of the static tension test on the -13 mm joint. Figures 27 and 28 give the results of the static tension test on the +13 mm joint. It is stated that reported joint openings are relative to the joint width at installation.

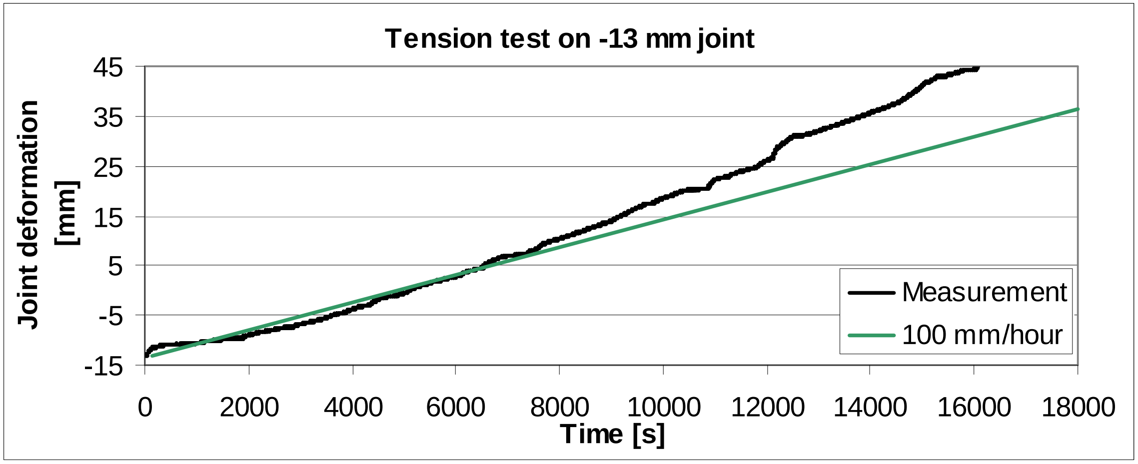


Figure 25. Deformation applied to the -13 mm joint during the static tension test. The straight line represents the protocol.

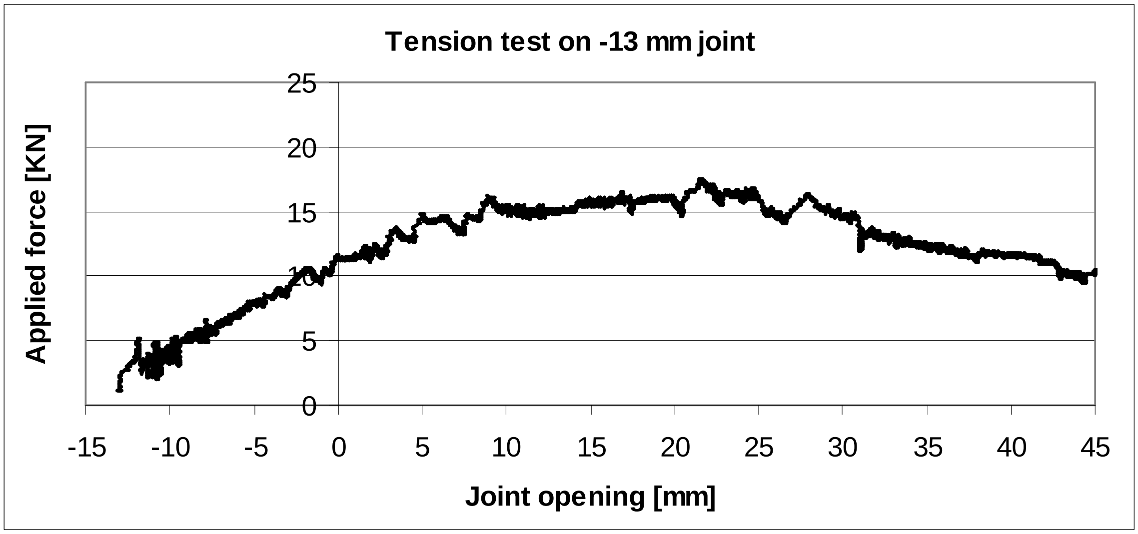


Figure 26. Obtained force-displacement plot for the static tension test on the -13 mm joint.

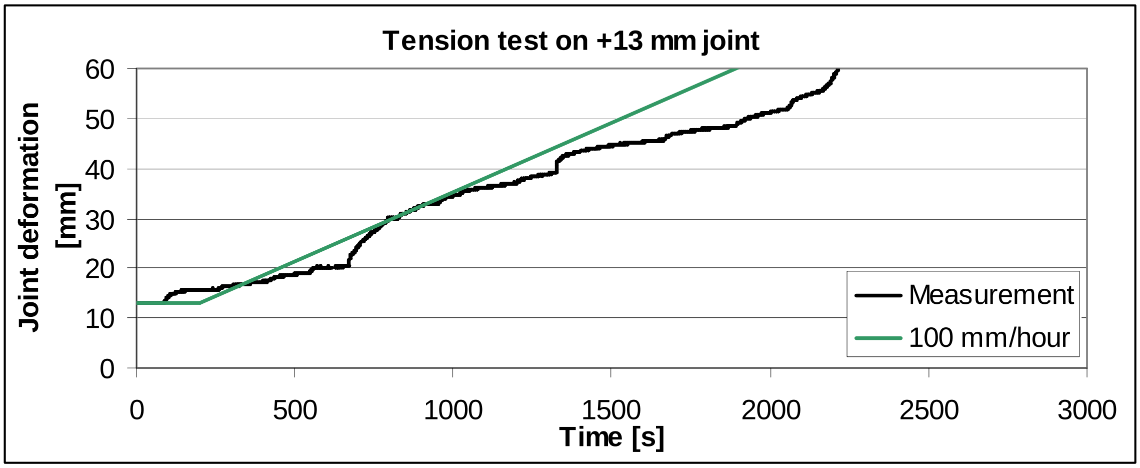


Figure 27. Deformation applied to the +13 mm joint during the static tension test. The straight line represents the protocol.

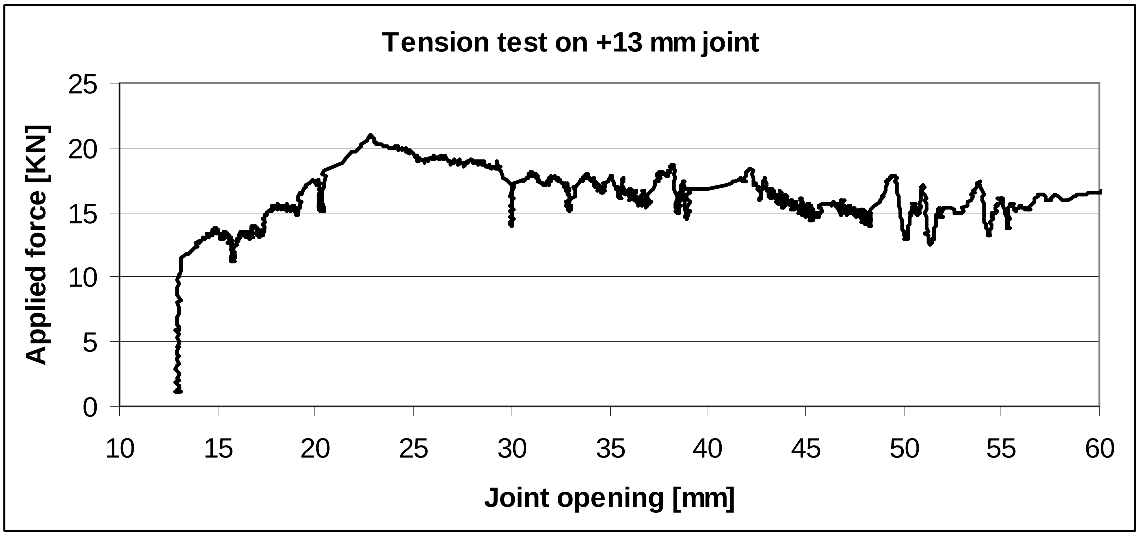


Figure 28. Obtained force-displacement plot for the static tension test on the +13 mm joint.

As shown from the force displacement plots i.e. Figure 26 and 28, the -13 mm joint fails at 21.8 mm opening. The +13 mm joint fails at 23.0 mm opening.

Apart from measurements photos were also made during the tension tests. On the basis of these photos it is concluded that the -13 mm joint showed first visual damage at an opening of 13.7 mm. For the +13 mm joint first visual damage was observed at an opening of 18.6 mm.
From the photos it is learned that failure of the -13 mm joint is initiated at the wheel path centre. Failure of the +13 mm joint is initiated by the development of

a crack at the joint edge just above a built in temperature gauge, see Figures 29 to 32.

Figure 29. The -13 mm joint just after visual failure. A crack develops at the wheel path centre exactly above the joint between bridge and bridge support.

Figure 30. Impression of the -13 mm joint after failure.

Figure 31. The +13 mm joint at visual failure. A crack develops at the left edge of the joint exactly above the built-in temperature gauge. The crack at the right edge first appeared after initial joint opening.

Figure 32. Impression of the +13 mm joint after failure.

Table 6. Summary of static tension test results.

	Opening at max. force failure [mm]	Opening at visual damage failure [mm]
-13 mm joint	21.8	13.7
+13 mm joint	23.0	18.6

See Appendix D for a photo report of both static tension tests.

6. CONCLUSIOS & RECOMENDATIONS

6.1 Conclusions

From the tests on the Prefab Silent Joint system the following conclusions are drawn.

- It was observed and measured that the tested Prefab Silent Joint system performed well during repeated loading.
- The observed joint rutting behaviour was significantly better than the rutting behaviour of the surrounding bridge deck surfacing structure.
- The test on the Prefab Silent Joint system was stopped because of severe longitudinal unevenness caused by depressions in the surrounding surfacing structure.
- Indications are that the rutting behaviour of the Prefab Silent Joint system is not much dependant on both temperature and wheel load, see figures 17 and 18.
- Differences were observed in the rutting behaviour of the +13 mm and -13 mm joint. The -13 mm joint showed minor temperature susceptibility and developed minor up heaves adjacent to the wheel path. This indicates that the rutting performance of the -13 mm joint is slightly worse than that of the +13 mm joint.
- Apart from rutting and the consequent longitudinal unevenness no damages developed in the Multi-joint.
- A minor defect was introduced in the +13 mm joint during initial opening.
- Failure of the Silent Joint System during the static tension test is introduced in the middle of the joint, i.e. over the physical joint in the concrete work.
- The maximum elongation at 25°C to first visual damage is limited to 16 mm on average. The elongation at maximum force is 22 mm on average.
- The results of the static tension test are not much dependant on deformation rate.
- The behaviour of the Silent Joint System shows only limited dependency on temperature and deformation rate. From this, and good rutting performance, it might be concluded that the Silent Joint System show limited visco-elastic behaviour.

6.2 Recommendations

- It is believed that the Silent Joint System may be further optimised. It was observed that first damage during elongation developed in the middle of the joint. This implies that the built-in springs do not function optimal.
- An interaction between the structural performance of the joint and the surrounding surfacing structure was observed. The causes of this interaction remain unknown. It is recommended to verify these observations during the road test of the Prefab Silent Joint.

- The Silent Joint System is purposely installed such that its surface is approximately 5 mm above the surrounding pavement. Given the good rutting performance of the system this may result in long lasting longitudinal unevenness. It is recommended to reconsider construction procedures with respect to this issue.

LITERATURE

1 M. Huurman, J. Moraal, LINTRACK research into expansion joint behaviour, Report 7-08-202-2, Section of Road and Railway Engineering, Delft University of Technology, Delft, 2009.

Appendix A

joint Quality Plan

Werk- en keuringsplan

van

Schagen infra BV

voor

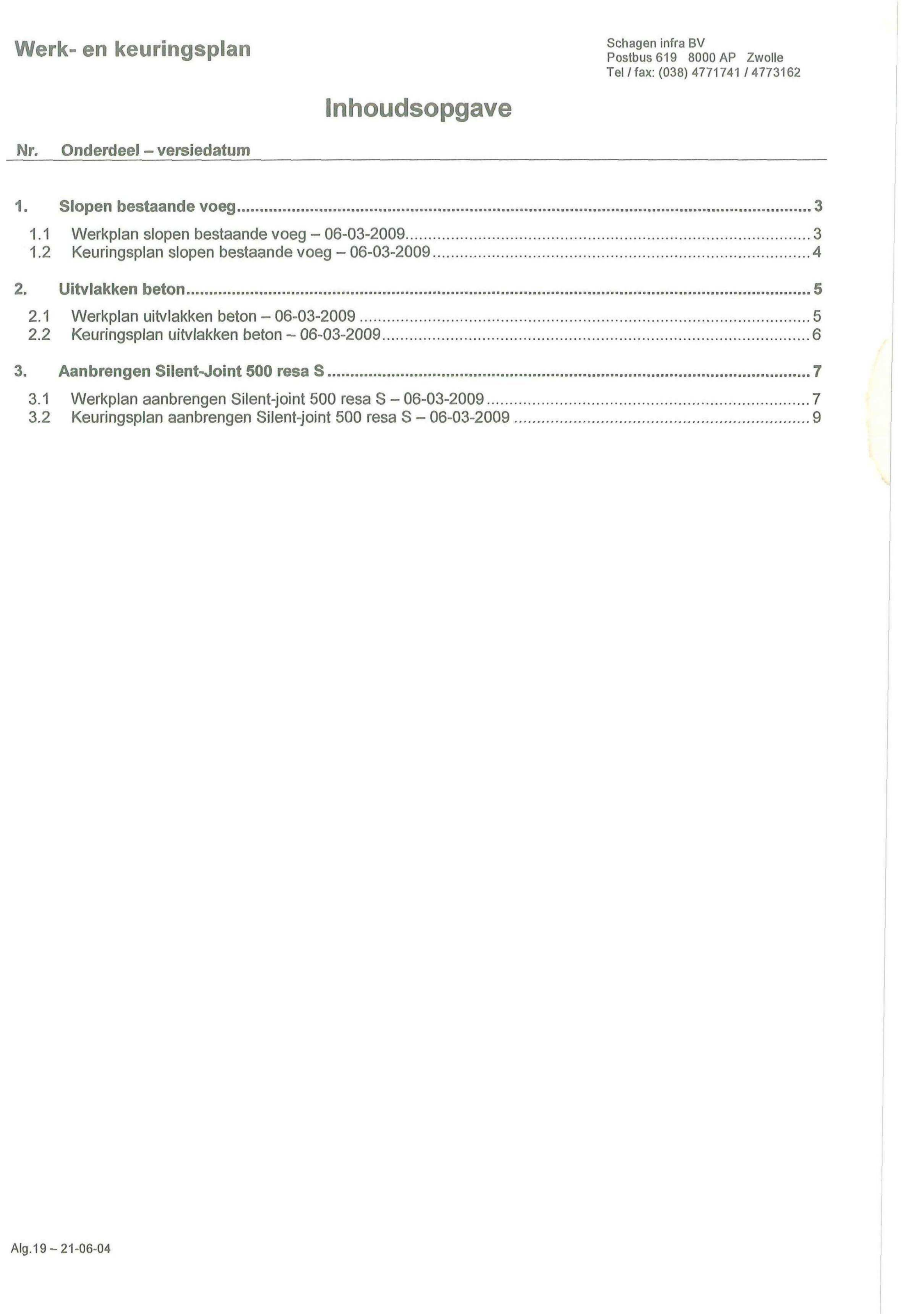
Bestek: Lintrac

WERK Inbouwen Lintrac element

Werknummer: 805537
Adres: Postbus 5044, 2600 GA
Plaats: Delft
Opdrachtgever: Rijkswaterstaat dienst Verkeer en Scheepvaart
Directie U.A.V.:
Contactpersoon: J. Voskuilen

Versie: 1
Hasselt 06-03-2009

Alg.19 – 21-06-04



Werk- en keuringsplan

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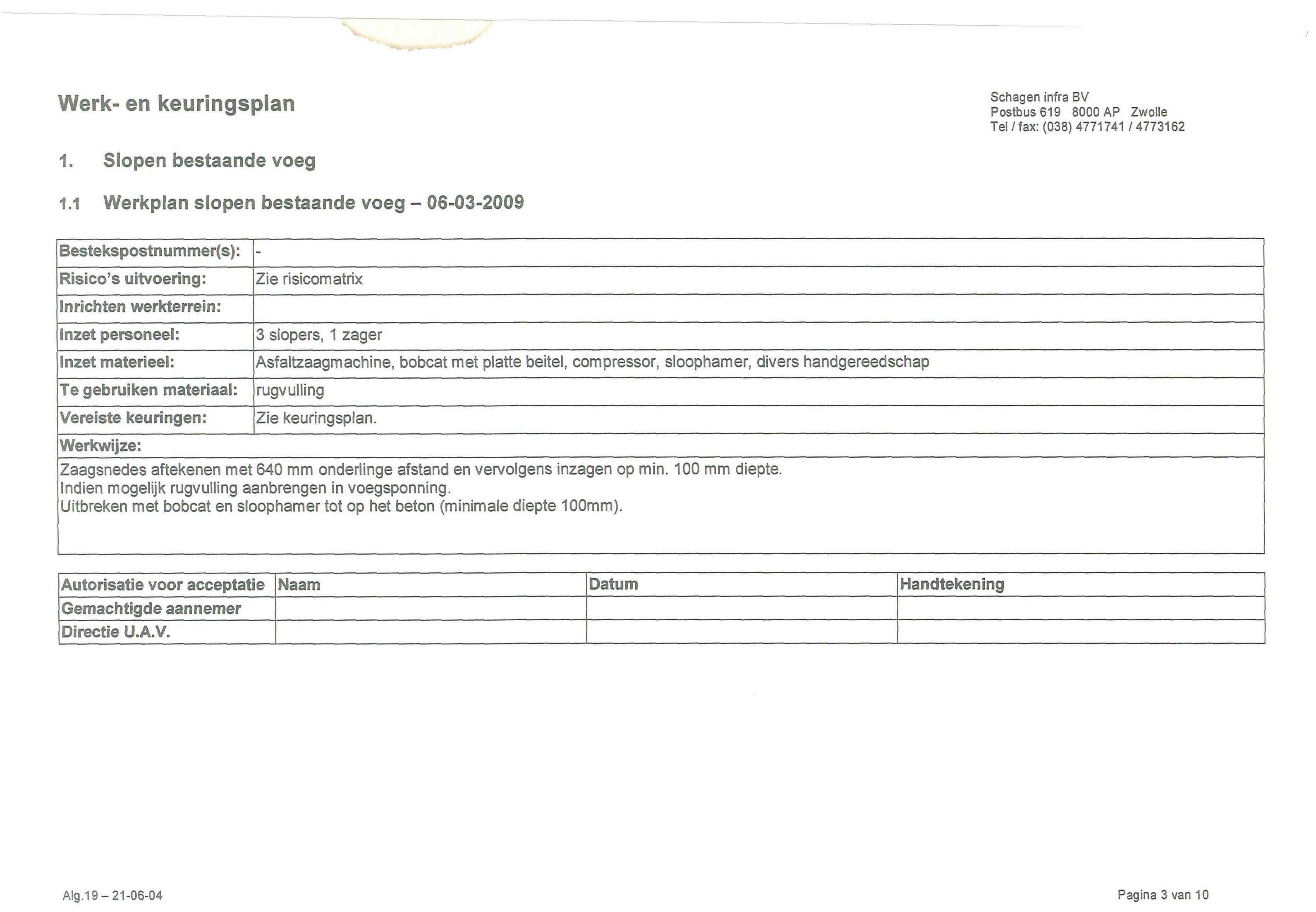
Inhoudsopgave

Nr. Onderdeel – versiedatum

Alg.19 – 21-06-04



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Werk- en keuringsplan

1. Slopen bestaande voeg

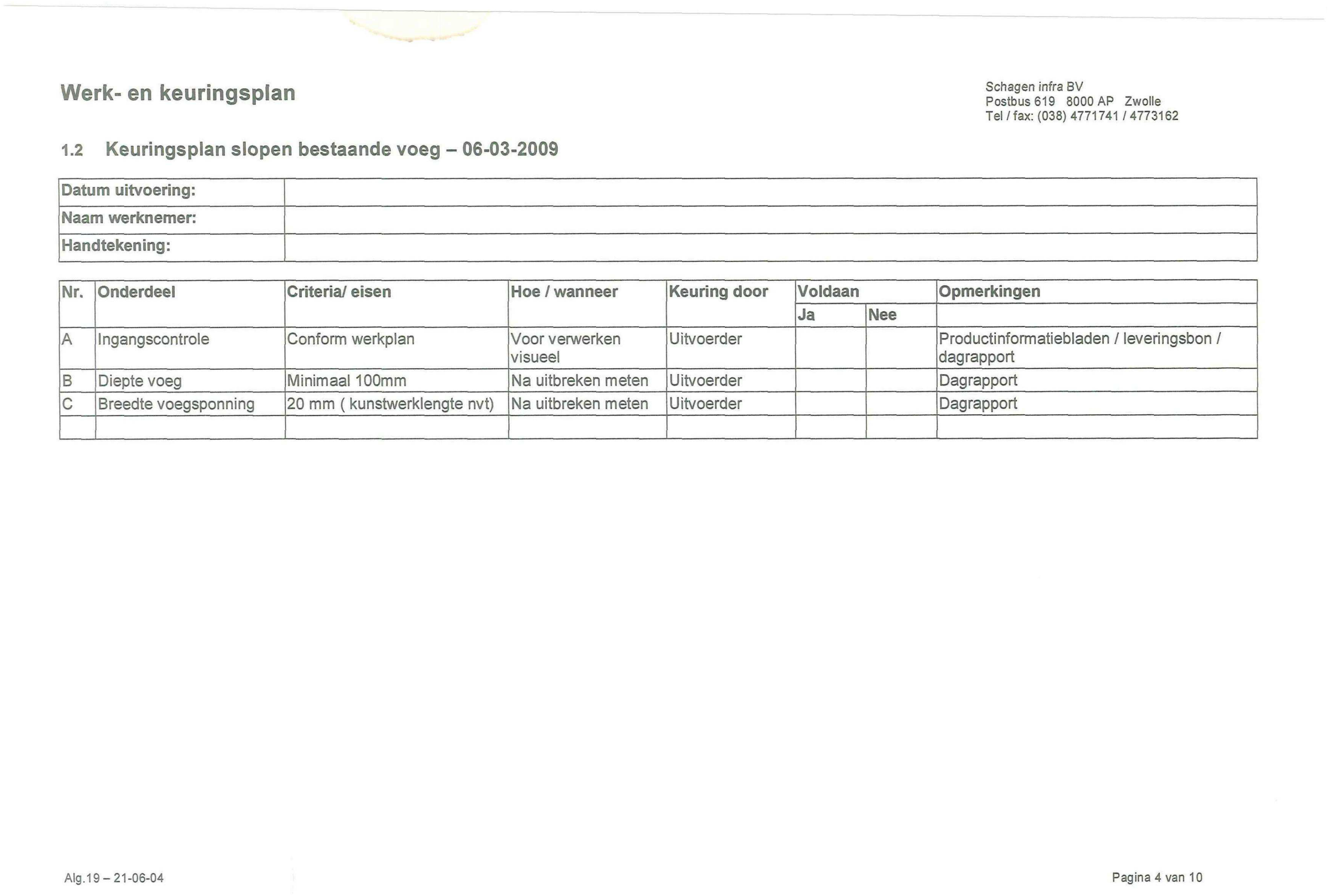
1.1 Werkplan slopen bestaande voeg – 06-03-2009

Bestekspostnummer(s):	-
Risico's uitvoering:	Zie risicomatrix
Inrichten werkterrein:	
Inzet personeel:	3 slopers, 1 zager
Inzet materieel:	Asfaltzaagmachine, bobcat met platte beitel, compressor, sloophamer, divers handgereedschap
Te gebruiken materiaal:	rugvulling
Vereiste keuringen:	Zie keuringsplan.

Werkwijze:

Zaagsnedes aftekenen met 640 mm onderlinge afstand en vervolgens inzagen op min. 100 mm diepte.
Indien mogelijk rugvulling aanbrengen in voegsponning.
Uitbreken met bobcat en sloophamer tot op het beton (minimale diepte 100mm).

Autorisatie voor acceptatie	**Naam**	**Datum**	**Handtekening**
Gemachtigde aannemer			
Directie U.A.V.			



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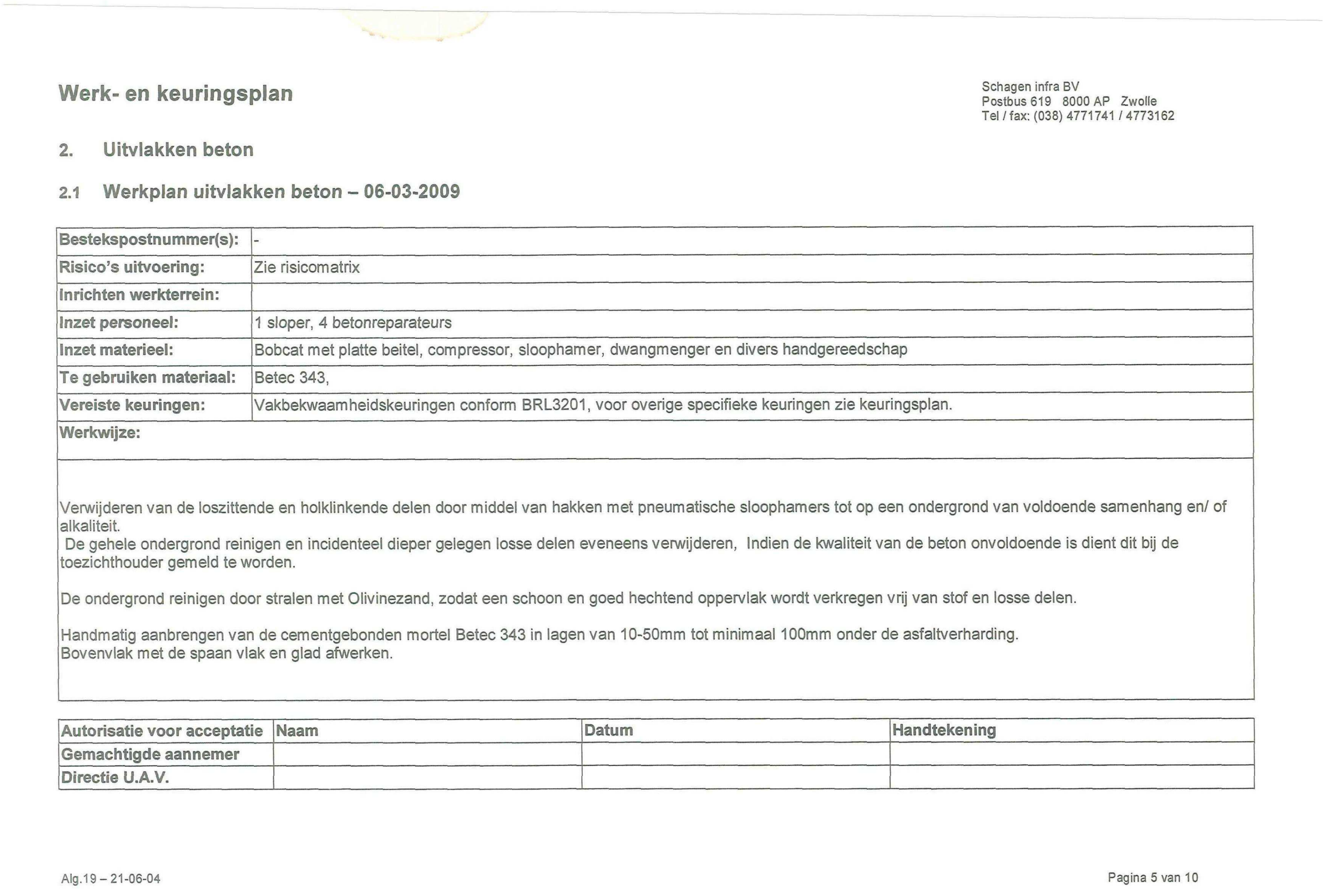
1.2 Keuringsplan slopen bestaande voeg – 06-03-2009

Datum uitvoering:	
Naam werknemer:	
Handtekening:	

Nr.	**Onderdeel**	**Criteria/ eisen**	**Hoe / wanneer**	**Keuring door**	**Voldaan**		**Opmerkingen**
					Ja	**Nee**	
A	Ingangscontrole	Conform werkplan	Voor verwerken visueel	Uitvoerder			Productinformatiebladen / leveringsbon / dagrapport
B	Diepte voeg	Minimaal 100mm	Na uitbreken meten	Uitvoerder			Dagrapport
C	Breedte voegsponning	20 mm (kunstwerklengte nvt)	Na uitbreken meten	Uitvoerder			Dagrapport



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2. Uitvlakken beton

2.1 Werkplan uitvlakken beton – 06-03-2009

Besteksposnummer(s):	-
Risico's uitvoering:	Zie risicomatrix
Inrichten werkterrein:	
Inzet personeel:	1 sloper, 4 betonreparateurs
Inzet materieel:	Bobcat met platte beitel, compressor, sloophamer, dwangmenger en divers handgereedschap
Te gebruiken materiaal:	Betec 343,
Vereiste keuringen:	Vakbekwaamheidskeuringen conform BRL3201, voor overige specifieke keuringen zie keuringsplan.
Werkwijze:	

Verwijderen van de loszittende en holklinkende delen door middel van hakken met pneumatische sloophamers tot op een ondergrond van voldoende samenhang en/ of alkaliteit.
De gehele ondergrond reinigen en incidenteel dieper gelegen losse delen eveneens verwijderen, Indien de kwaliteit van de beton onvoldoende is dient dit bij de toezichthouder gemeld te worden.

De ondergrond reinigen door stralen met Olivinezand, zodat een schoon en goed hechtend oppervlak wordt verkregen vrij van stof en losse delen.

Handmatig aanbrengen van de cementgebonden mortel Betec 343 in lagen van 10-50mm tot minimaal 100mm onder de asfaltverharding.
Bovenvlak met de spaan vlak en glad afwerken.

Autorisatie voor acceptatie	**Naam**	**Datum**	**Handtekening**
Gemachtigde aannemer			
Directie U.A.V.			

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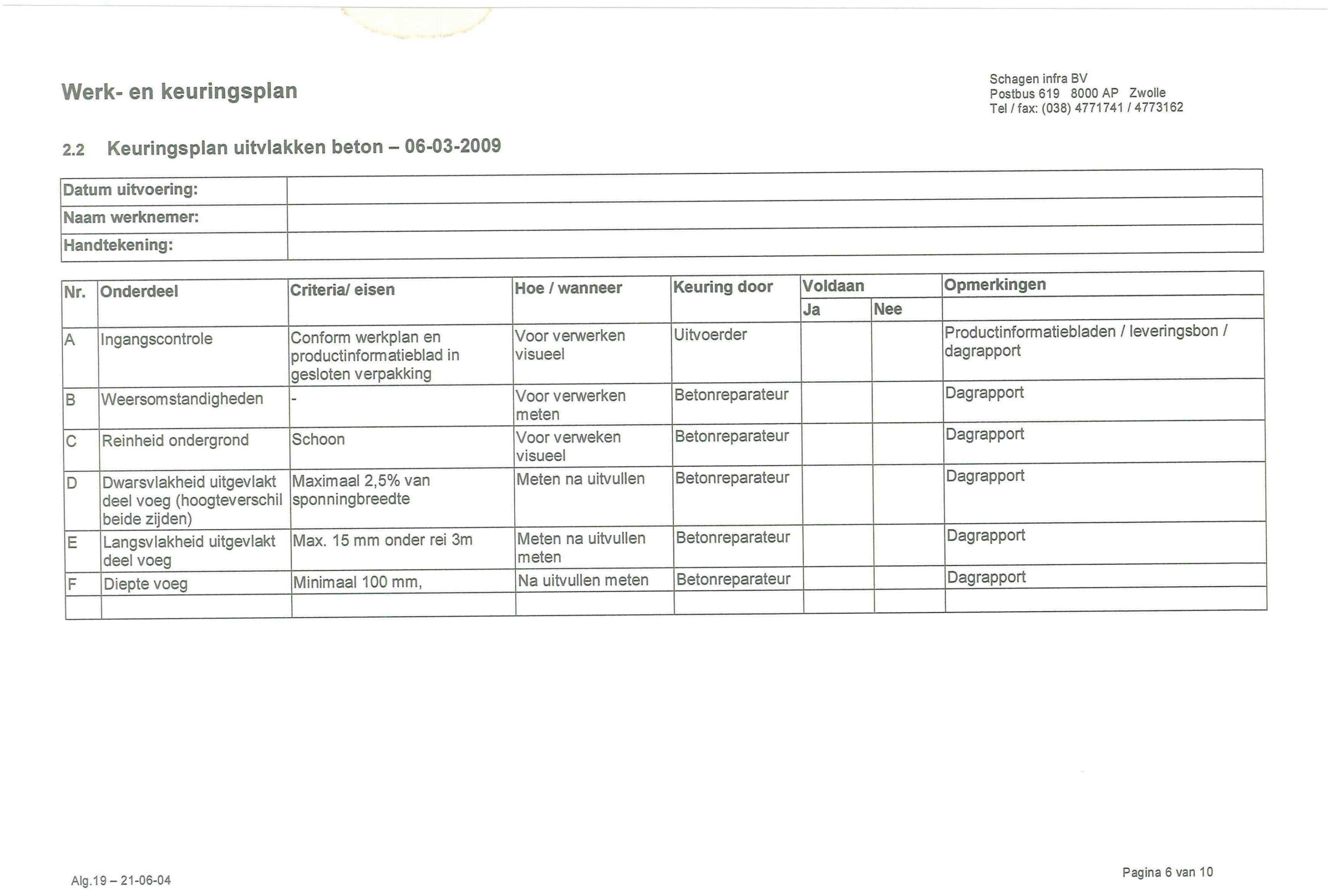
Pagina 5 van 10



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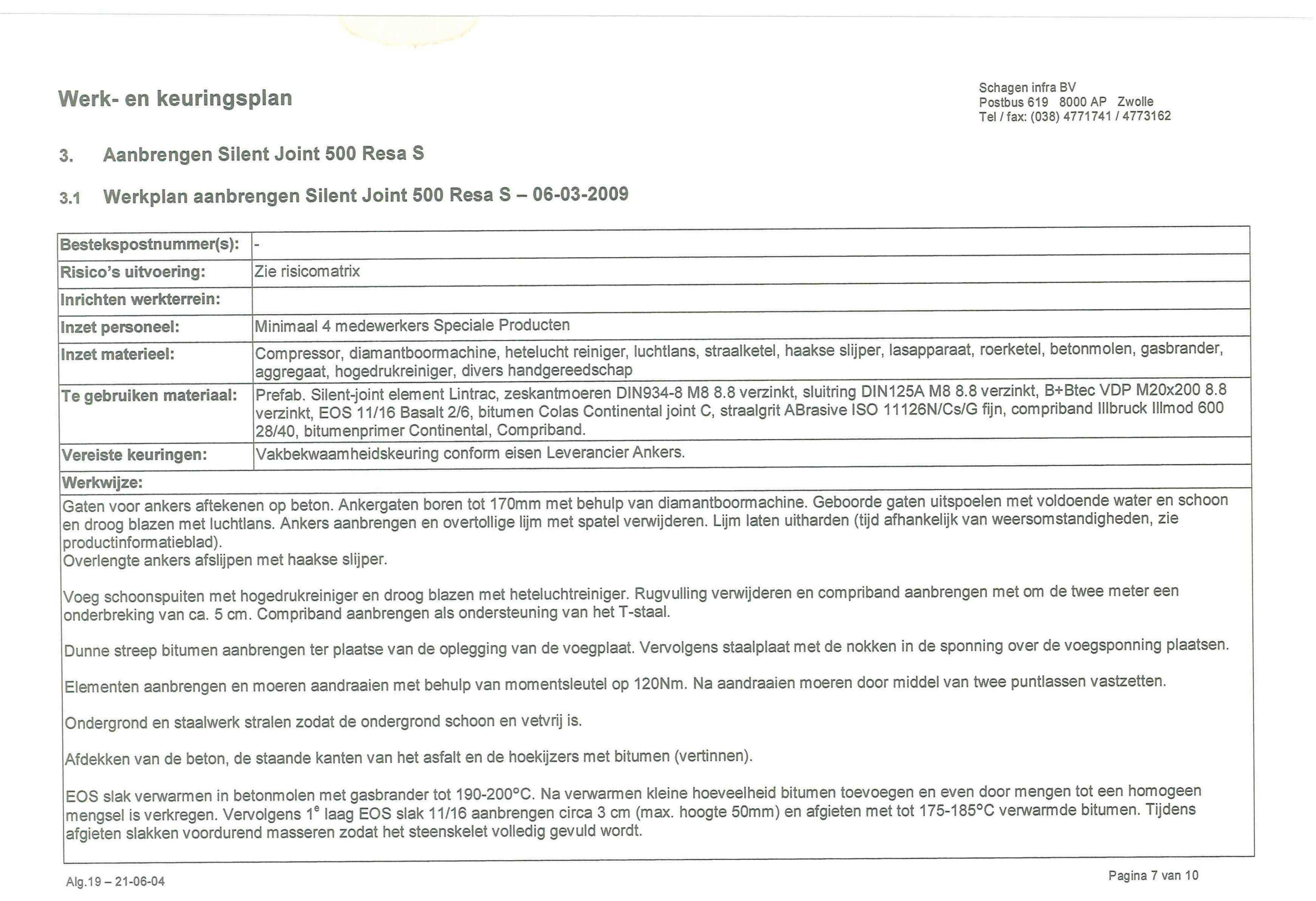
2.2 Keuringsplan uitvlakken beton – 06-03-2009

Datum uitvoering:	
Naam werknemer:	
Handtekening:	

Nr.	**Onderdeel**	**Criteria/ eisen**	**Hoe / wanneer**	**Keuring door**	**Voldaan**		**Opmerkingen**
					Ja	**Nee**	
A	Ingangscontrole	Conform werkplan en productinformatieblad in gesloten verpakking	Voor verwerken visueel	Uitvoerder			Productinformatiebladen / leveringsbon / dagrapport
B	Weersomstandigheden	-	Voor verwerken meten	Betonreparateur			Dagrapport
C	Reinheid ondergrond	Schoon	Voor verweken visueel	Betonreparateur			Dagrapport
D	Dwarsvlakheid uitgevlakt deel voeg (hoogteverschil beide zijden)	Maximaal 2,5% van sponningbreedte	Meten na uitvullen	Betonreparateur			Dagrapport
E	Langsvlakheid uitgevlakt deel voeg	Max. 15 mm onder rei 3m	Meten na uitvullen meten	Betonreparateur			Dagrapport
F	Diepte voeg	Minimaal 100 mm,	Na uitvullen meten	Betonreparateur			Dagrapport

Alg.19 – 21-06-04

Pagina 6 van 10



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Werk- en keuringsplan

3. Aanbrengen Silent Joint 500 Resa S

3.1 Werkplan aanbrengen Silent Joint 500 Resa S – 06-03-2009

Bestekspostnummer(s):	-
Risico's uitvoering:	Zie risicomatrix
Inrichten werkterrein:	
Inzet personeel:	Minimaal 4 medewerkers Speciale Producten
Inzet materieel:	Compressor, diamantboormachine, hetelucht reiniger, luchtlans, straalketel, haakse slijper, lasapparaat, roerketel, betonmolen, gasbrander, aggregaat, hogedrukreiniger, divers handgereedschap
Te gebruiken materiaal:	Prefab. Silent-joint element Lintrac, zeskantmoeren DIN934-8 M8 8.8 verzinkt, sluitring DIN125A M8 8.8 verzinkt, B+Btec VDP M20x200 8.8 verzinkt, EOS 11/16 Basalt 2/6, bitumen Colas Continental joint C, straalgrit ABrasive ISO 11126N/Cs/G fijn, compriband Illbruck Illmod 600 28/40, bitumenprimer Continental, Compriband.
Vereiste keuringen:	Vakbekwaamheidskeuring conform eisen Leverancier Ankers.

Werkwijze:

Gaten voor ankers aftekenen op beton. Ankergaten boren tot 170mm met behulp van diamantboormachine. Geboorde gaten uitspoelen met voldoende water en schoon en droog blazen met luchtlans. Ankers aanbrengen en overtollige lijm met spatel verwijderen. Lijm laten uitharden (tijd afhankelijk van weersomstandigheden, zie productinformatieblad).
Overlengte ankers afslijpen met haakse slijper.

Voeg schoonspuiten met hogedrukreiniger en droog blazen met heteluchtreiniger. Rugvulling verwijderen en compriband aanbrengen met om de twee meter een onderbreking van ca. 5 cm. Compriband aanbrengen als ondersteuning van het T-staal.

Dunne streep bitumen aanbrengen ter plaatse van de oplegging van de voegplaat. Vervolgens staalplaat met de nokken in de sponning over de voegsponning plaatsen.

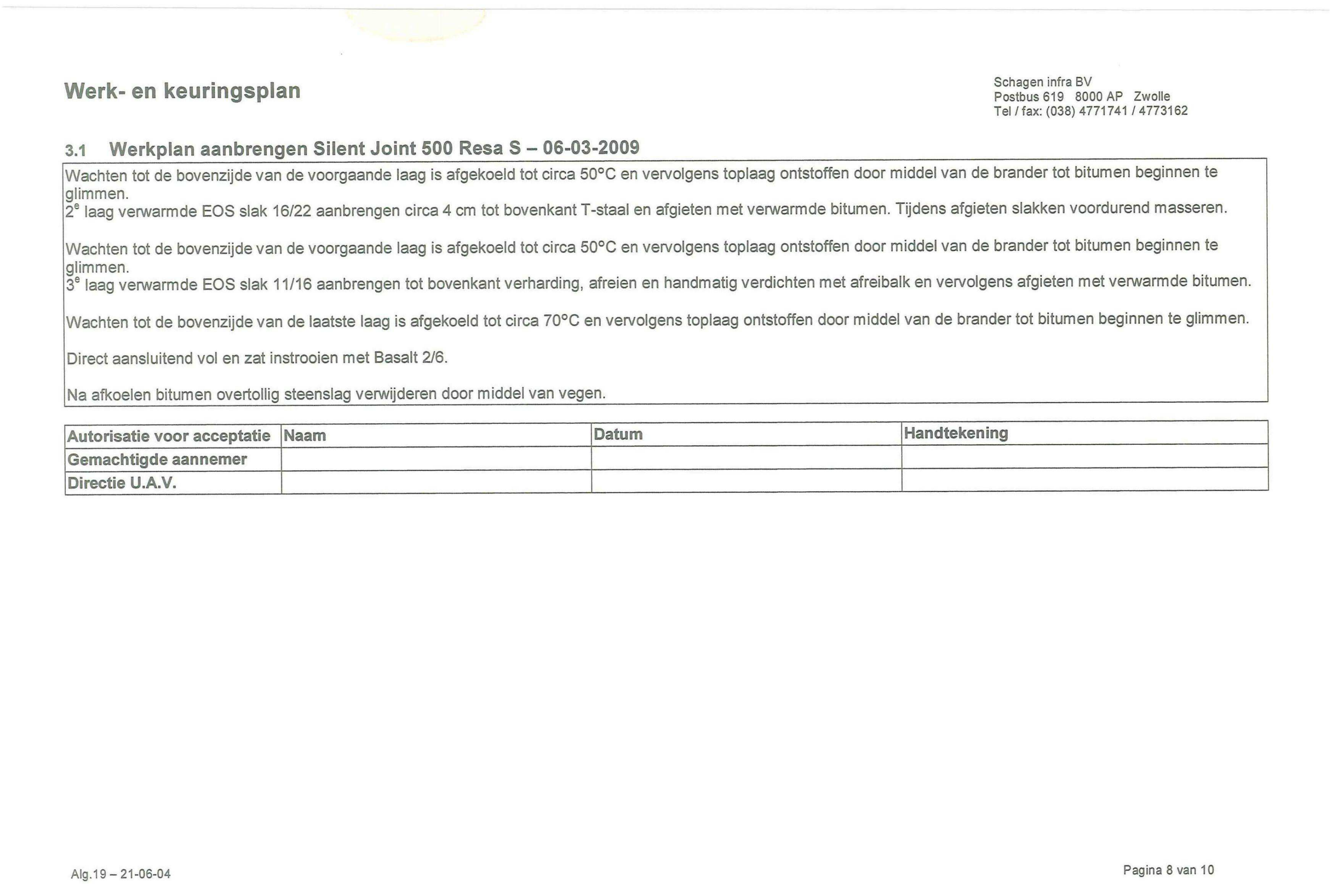
Elementen aanbrengen en moeren aandraaien met behulp van momentsleutel op 120Nm. Na aandraaien moeren door middel van twee puntlassen vastzetten.

Ondergrond en staalwerk stralen zodat de ondergrond schoon en vetvrij is.

Afdekken van de beton, de staande kanten van het asfalt en de hoekijzers met bitumen (vertinnen).

EOS slak verwarmen in betonmolen met gasbrander tot 190-200°C. Na verwarmen kleine hoeveelheid bitumen toevoegen en even door mengen tot een homogeen mengsel is verkregen. Vervolgens 1^e laag EOS slak 11/16 aanbrengen circa 3 cm (max. hoogte 50mm) en afgieten met tot 175-185°C verwarmde bitumen. Tijdens afgieten slakken voordurend masseren zodat het steenskelet volledig gevuld wordt.

Alg.19 – 21-06-04
Pagina 7 van 10



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3.1 Werkplan aanbrengen Silent Joint 500 Resa S – 06-03-2009

Wachten tot de bovenzijde van de voorgaande laag is afgekoeld tot circa 50°C en vervolgens toplaag ontstoffen door middel van de brander tot bitumen beginnen te glimmen.
2^e laag verwarmde EOS slak 16/22 aanbrengen circa 4 cm tot bovenkant T-staal en afgieten met verwarmde bitumen. Tijdens afgieten slakken voordurend masseren.

Wachten tot de bovenzijde van de voorgaande laag is afgekoeld tot circa 50°C en vervolgens toplaag ontstoffen door middel van de brander tot bitumen beginnen te glimmen.
3^e laag verwarmde EOS slak 11/16 aanbrengen tot bovenkant verharding, afreien en handmatig verdichten met afreibalk en vervolgens afgieten met verwarmde bitumen.

Wachten tot de bovenzijde van de laatste laag is afgekoeld tot circa 70°C en vervolgens toplaag ontstoffen door middel van de brander tot bitumen beginnen te glimmen.

Direct aansluitend vol en zat instrooien met Basalt 2/6.

Na afkoelen bitumen overtollig steenslag verwijderen door middel van vegen.

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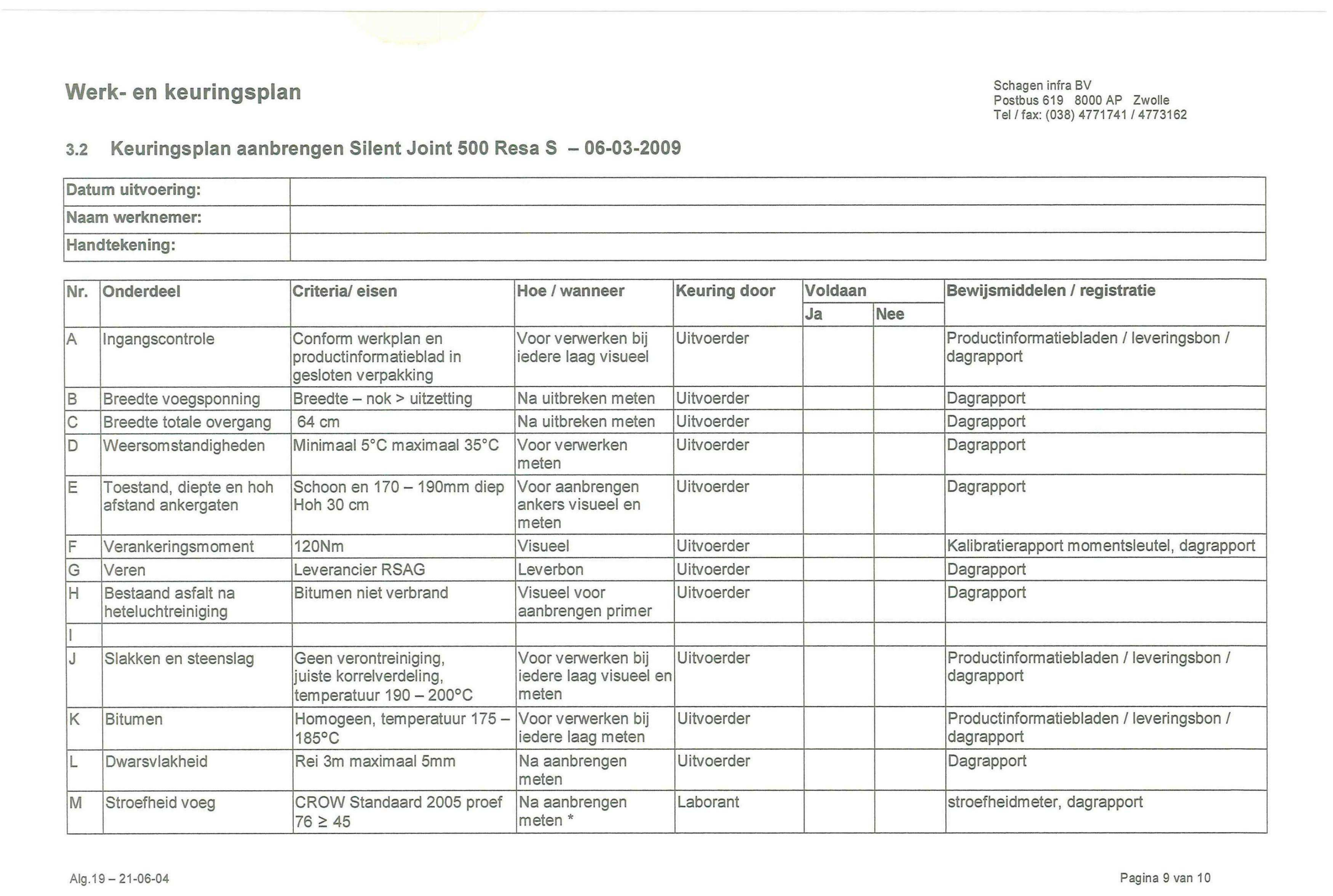
Directie U.A.V.			



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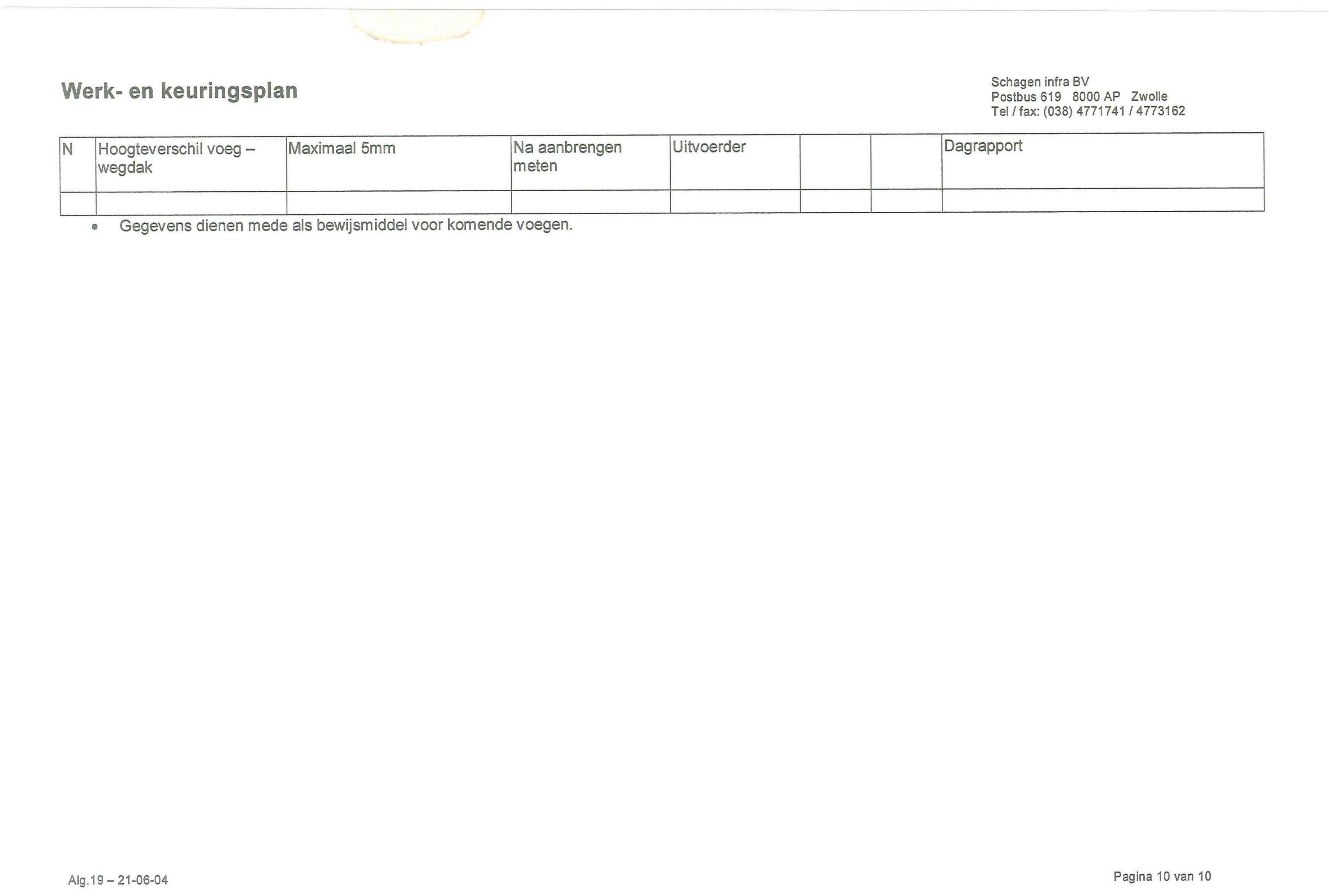
3.2 Keuringsplan aanbrengen Silent Joint 500 Resa S – 06-03-2009

Datum uitvoering:	
Naam werknemer:	
Handtekening:	

Nr.	**Onderdeel**	**Criteria/ eisen**	**Hoe / wanneer**	**Keuring door**	**Voldaan**		**Bewijsmiddelen / registratie**
					Ja	**Nee**	
A	Ingangscontrole	Conform werkplan en productinformatieblad in gesloten verpakking	Voor verwerken bij iedere laag visueel	Uitvoerder			Productinformatiebladen / leveringsbon / dagrapport
B	Breedte voegsponning	Breedte – nok > uitzetting	Na uitbreken meten	Uitvoerder			Dagrapport
C	Breedte totale overgang	64 cm	Na uitbreken meten	Uitvoerder			Dagrapport
D	Weersomstandigheden	Minimaal 5°C maximaal 35°C	Voor verwerken meten	Uitvoerder			Dagrapport
E	Toestand, diepte en hoh afstand ankergaten	Schoon en 170 – 190mm diep Hoh 30 cm	Voor aanbrengen ankers visueel en meten	Uitvoerder			Dagrapport
F	Verankeringsmoment	120Nm	Visueel	Uitvoerder			Kalibratierapport momentsleutel, dagrapport
G	Veren	Leverancier RSAG	Leverbon	Uitvoerder			Dagrapport
H	Bestaand asfalt na heteluchtreiniging	Bitumen niet verbrand	Visueel voor aanbrengen primer	Uitvoerder			Dagrapport
I							
J	Slakken en steenslag	Geen verontreiniging, juiste korrelverdeling, temperatuur 190 – 200°C	Voor verwerken bij iedere laag visueel en meten	Uitvoerder			Productinformatiebladen / leveringsbon / dagrapport
K	Bitumen	Homogeen, temperatuur 175 – 185°C	Voor verwerken bij iedere laag meten	Uitvoerder			Productinformatiebladen / leveringsbon / dagrapport
L	Dwarsvlakheid	Rei 3m maximaal 5mm	Na aanbrengen meten	Uitvoerder			Dagrapport
M	Stroefheid voeg	CROW Standaard 2005 proef 76 ≥ 45	Na aanbrengen meten *	Laborant			stroefheidmeter, dagrapport



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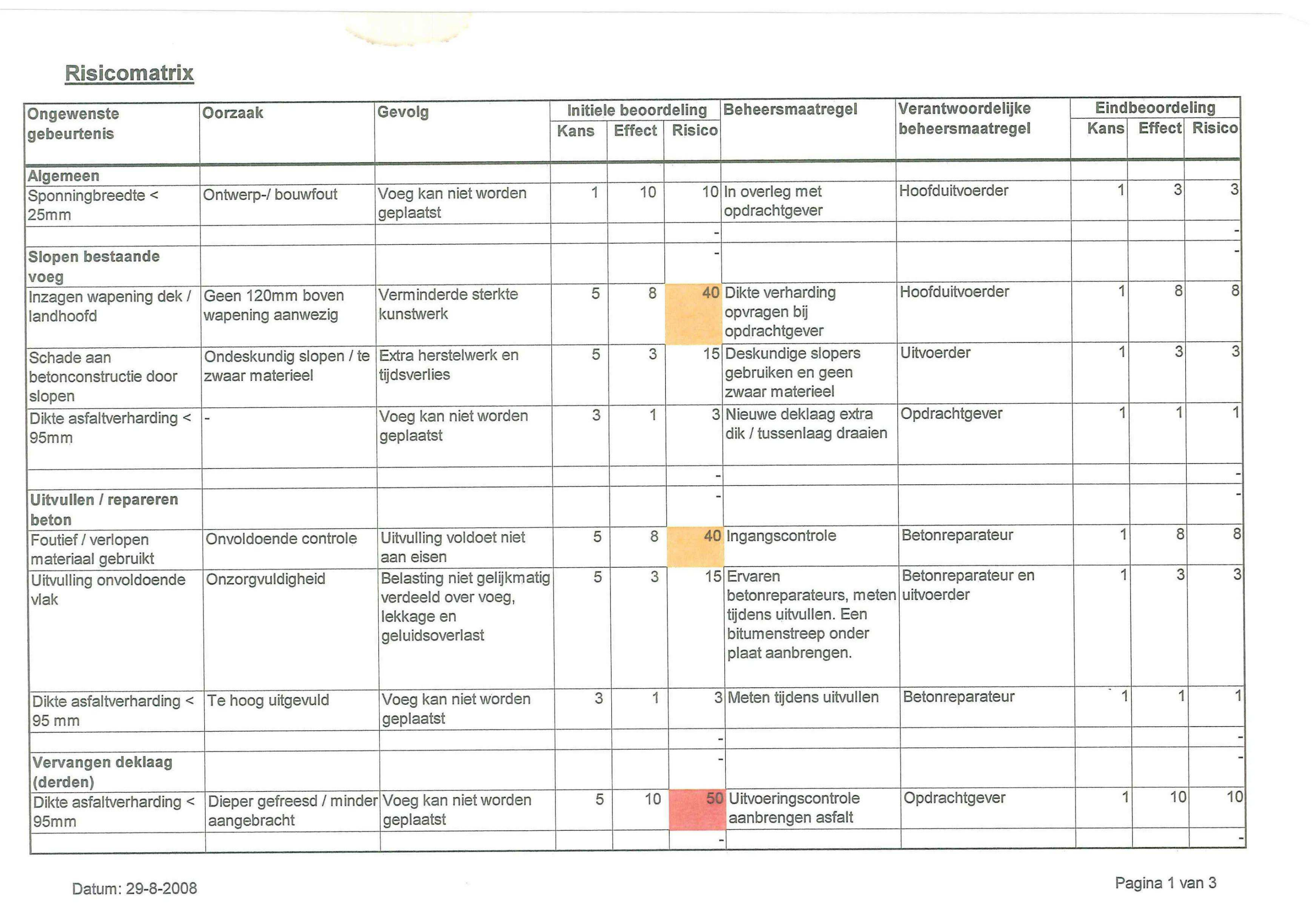
N	Hoogteverschil voeg – wegdak	Maximaal 5mm	Na aanbrengen meten	Uitvoerder			Dagrapport

- Gegevens dienen mede als bewijsmiddel voor komende voegen.

Alg.19 – 21-06-04

Pagina 10 van 10

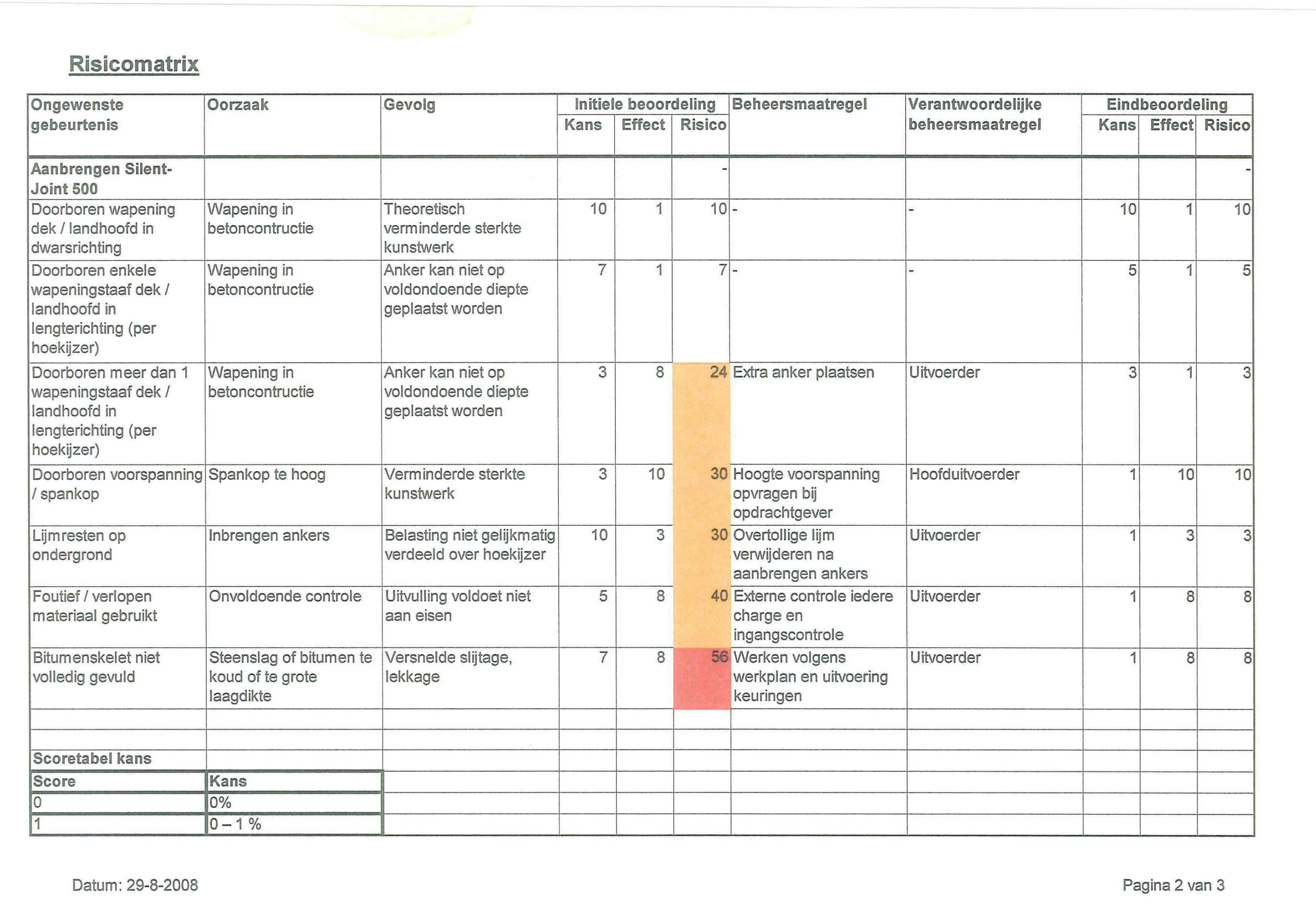


Risicomatrix

Ongewenste gebeurtenis	Oorzaak	Gevolg	Initiele beoordeling			Beheersmaatregel	Verantwoordelijke beheersmaatregel	Eindbeoordeling		
			Kans	Effect	Risico			Kans	Effect	Risico
Algemeen										
Sponningbreedte < 25mm	Ontwerp-/ bouwfout	Voeg kan niet worden geplaatst	1	10	10	In overleg met opdrachtgever	Hoofduitvoerder	1	3	3
					-					-
Slopen bestaande voeg					-					-
Inzagen wapening dek / landhoofd	Geen 120mm boven wapening aanwezig	Verminderde sterkte kunstwerk	5	8	40	Dikte verharding opvragen bij opdrachtgever	Hoofduitvoerder	1	8	8
Schade aan betonconstructie door slopen	Ondeskundig slopen / te zwaar materieel	Extra herstelwerk en tijdsverlies	5	3	15	Deskundige slopers gebruiken en geen zwaar materieel	Uitvoerder	1	3	3
Dikte asfaltverharding < 95mm	-	Voeg kan niet worden geplaatst	3	1	3	Nieuwe deklaag extra dik / tussenlaag draaien	Opdrachtgever	1	1	1
					-					-
Uitvullen / repareren beton					-					-
Foutief / verlopen materiaal gebruikt	Onvoldoende controle	Uitvulling voldoet niet aan eisen	5	8	40	Ingangscontrole	Betonreparateur	1	8	8
Uitvulling onvoldoende vlak	Onzorgvuldigheid	Belasting niet gelijkmatig verdeeld over voeg, lekkage en geluidsoverlast	5	3	15	Ervaren betonreparateurs, meten tijdens uitvullen. Een bitumenstreep onder plaat aanbrengen.	Betonreparateur en uitvoerder	1	3	3
Dikte asfaltverharding < 95 mm	Te hoog uitgevuld	Voeg kan niet worden geplaatst	3	1	3	Meten tijdens uitvullen	Betonreparateur	1	1	1
					-					-
Vervangen deklaag (derden)					-					-
Dikte asfaltverharding < 95mm	Dieper gefreesd / minder aangebracht	Voeg kan niet worden geplaatst	5	10	50	Uitvoeringscontrole aanbrengen asfalt	Opdrachtgever	1	10	10
					-					-

Datum: 29-8-2008

Pagina 1 van 3



Risicomatrix

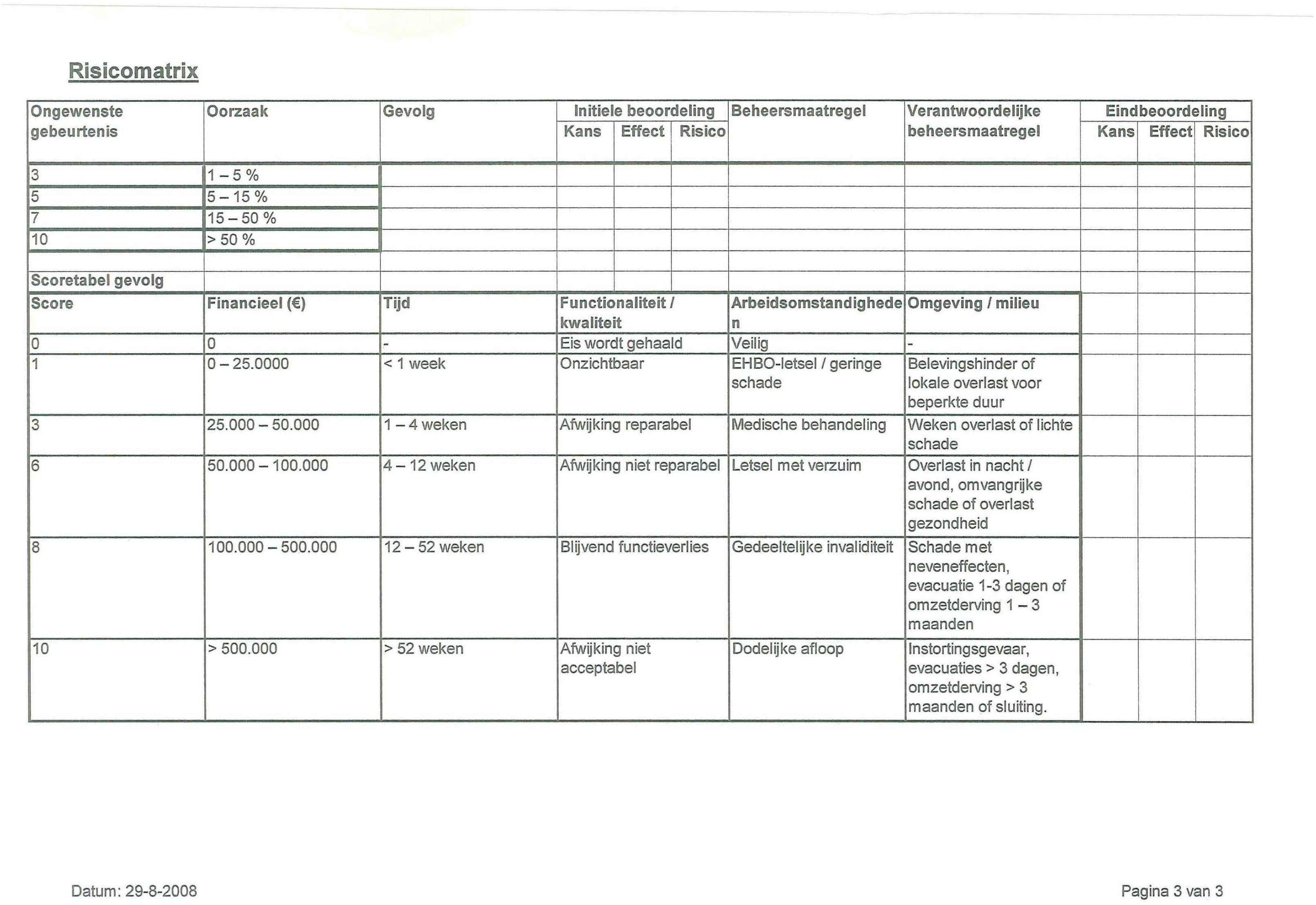
Ongewenste gebeurtenis	Oorzaak	Gevolg	Initiele beoordeling			Beheersmaatregel	Verantwoordelijke beheersmaatregel	Eindbeoordeling		
			Kans	Effect	Risico			Kans	Effect	Risico
Aanbrengen Silent-Joint 500					-					-
Doorboren wapening dek / landhoofd in dwarsrichting	Wapening in betoncontructie	Theoretisch verminderde sterkte kunstwerk	10	1	10	-	-	10	1	10
Doorboren enkele wapeningstaaf dek / landhoofd in lengterichting (per hoekijzer)	Wapening in betoncontructie	Anker kan niet op voldoendoende diepte geplaatst worden	7	1	7	-	-	5	1	5
Doorboren meer dan 1 wapeningstaaf dek / landhoofd in lengterichting (per hoekijzer)	Wapening in betoncontructie	Anker kan niet op voldondoende diepte geplaatst worden	3	8	24	Extra anker plaatsen	Uitvoerder	3	1	3
Doorboren voorspanning / spankop	Spankop te hoog	Verminderde sterkte kunstwerk	3	10	30	Hoogte voorspanning opvragen bij opdrachtgever	Hoofduitvoerder	1	10	10
Lijmresten op ondergrond	Inbrengen ankers	Belasting niet gelijkmatig verdeeld over hoekijzer	10	3	30	Overtollige lijm verwijderen na aanbrengen ankers	Uitvoerder	1	3	3
Foutief / verlopen materiaal gebruikt	Onvoldoende controle	Uitvulling voldoet niet aan eisen	5	8	40	Externe controle iedere charge en ingangscontrole	Uitvoerder	1	8	8
Bitumenskelet niet volledig gevuld	Steenslag of bitumen te koud of te grote laagdikte	Versnelde slijtage, lekkage	7	8	56	Werken volgens werkplan en uitvoering keuringen	Uitvoerder	1	8	8

Scoretabel kans

Score	Kans
0	0%
1	0 – 1 %

Datum: 29-8-2008

Pagina 2 van 3



Risicomatrix

Ongewenste gebeurtenis	Oorzaak	Gevolg	Initiele beoordeling			Beheersmaatregel	Verantwoordelijke beheersmaatregel	Eindbeoordeling		
			Kans	Effect	Risico			Kans	Effect	Risico
3	1 – 5 %									
5	5 – 15 %									
7	15 – 50 %									
10	> 50 %									

Scoretabel gevolg

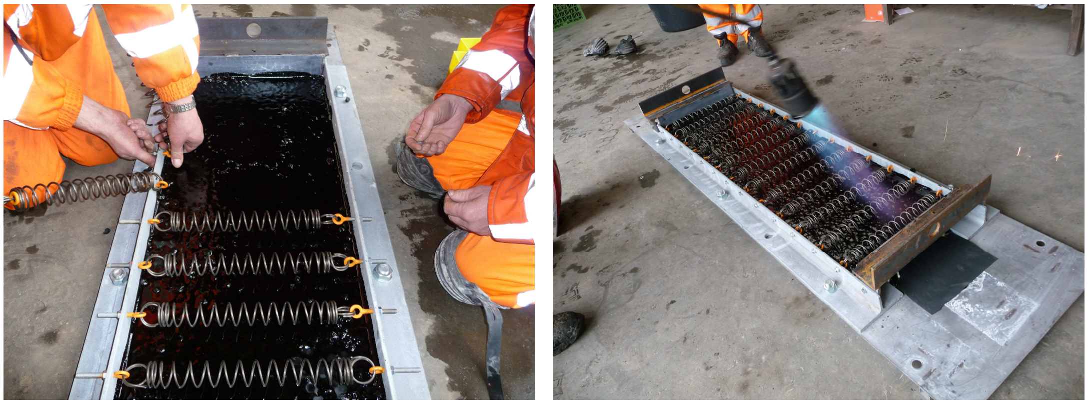
Score	Financieel (€)	Tijd	Functionaliteit / kwaliteit	Arbeidsomstandigheden	Omgeving / milieu
0	0	-	Eis wordt gehaald	Veilig	-
1	0 – 25.0000	< 1 week	Onzichtbaar	EHBO-letsel / geringe schade	Belevingshinder of lokale overlast voor beperkte duur
3	25.000 – 50.000	1 – 4 weken	Afwijking reparabel	Medische behandeling	Weken overlast of lichte schade
6	50.000 – 100.000	4 – 12 weken	Afwijking niet reparabel	Letsel met verzuim	Overlast in nacht / avond, omvangrijke schade of overlast gezondheid
8	100.000 – 500.000	12 – 52 weken	Blijvend functieverlies	Gedeeltelijke invaliditeit	Schade met neveneffecten, evacuatie 1-3 dagen of omzetderving 1 – 3 maanden
10	> 500.000	> 52 weken	Afwijking niet acceptabel	Dodelijke afloop	Instortingsgevaar, evacuaties > 3 dagen, omzetderving > 3 maanden of sluiting.

Datum: 29-8-2008

Pagina 3 van 3

Appendix B

Silent Joint installation



Construction of prefab element at contractor's yard. Left: Installation of springs after application of lower bituminous layer. Right: heating of springs and lower joint body layer.

Construction of prefab element at contractor's yard. Left: application of pre heated mineral for second joint body layer. Right: application of binder into second layer.

Construction of prefab element at contractor's yard. Left: close up of patch work due to limited availability of joint body material. Right: finished product and proud team.

Left: Situation at start of prefab element installation. Right: Cutting of joint trough.

Left: Joint substrate repair. Right: Sandblasting of prefab Silent Joint.

Left: Sandblasting of concrete substrate. Right: Heating of adjacent asphalt structure.

Left: Application of compressive bedding. Right: Installation of bituminous material for embedment of metal strip.

Left: Installation of joint bridging strip. Right: Installation of Prefab Silent Joint.

Application of bituminous binder after tightening of the bolds that anchor the prefab element.

Left: Installation of outer springs. Right: heating of mineral.

Filling of the trough with prefab joint element. Left: Levelling of the skeleton of pre heated mineral. Right: Bituminous binder is worked into the skeleton of pre heated mineral.

Application of small sized chippings on the Prefab Silent Joint surface.

Appendix C

Visual inspections

Rutting at N=0. Left: +13 mm joint, right: -13mm joint.

Rutting at N=10000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=20000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=30000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=40000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=50000. Left: +13 mm joint, right: -13mm joint.

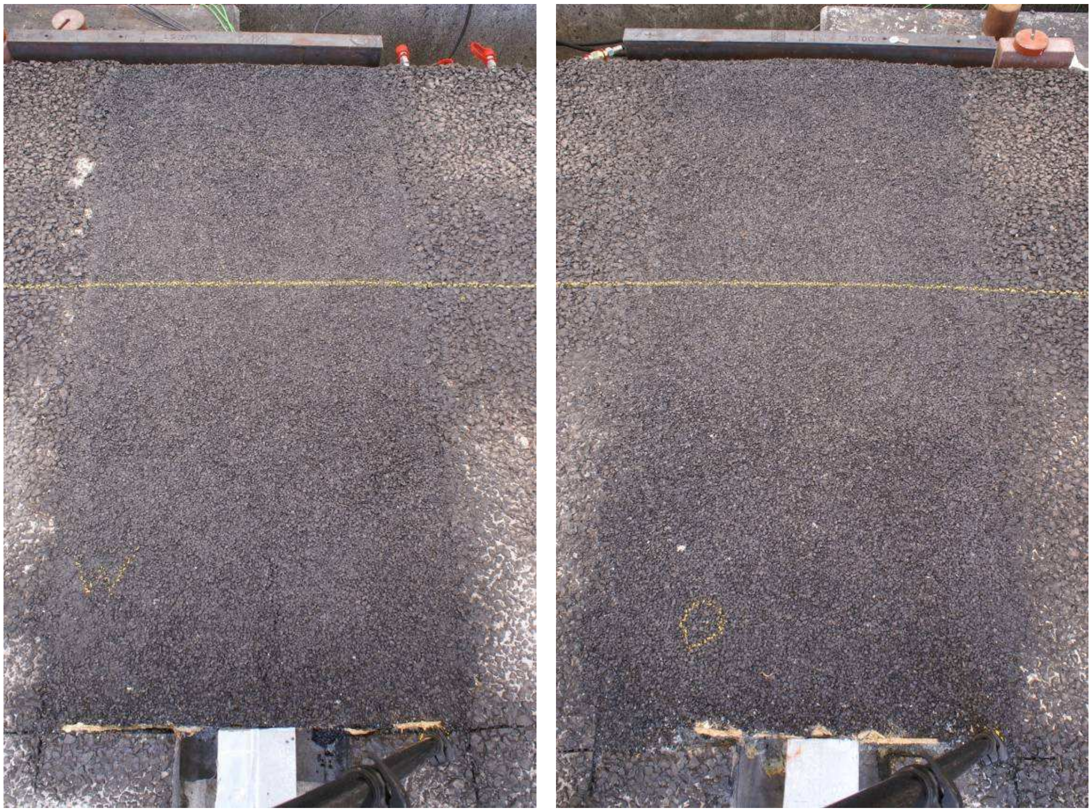
Rutting at N=60000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=70000. Left: +13 mm joint, right: -13mm joint.

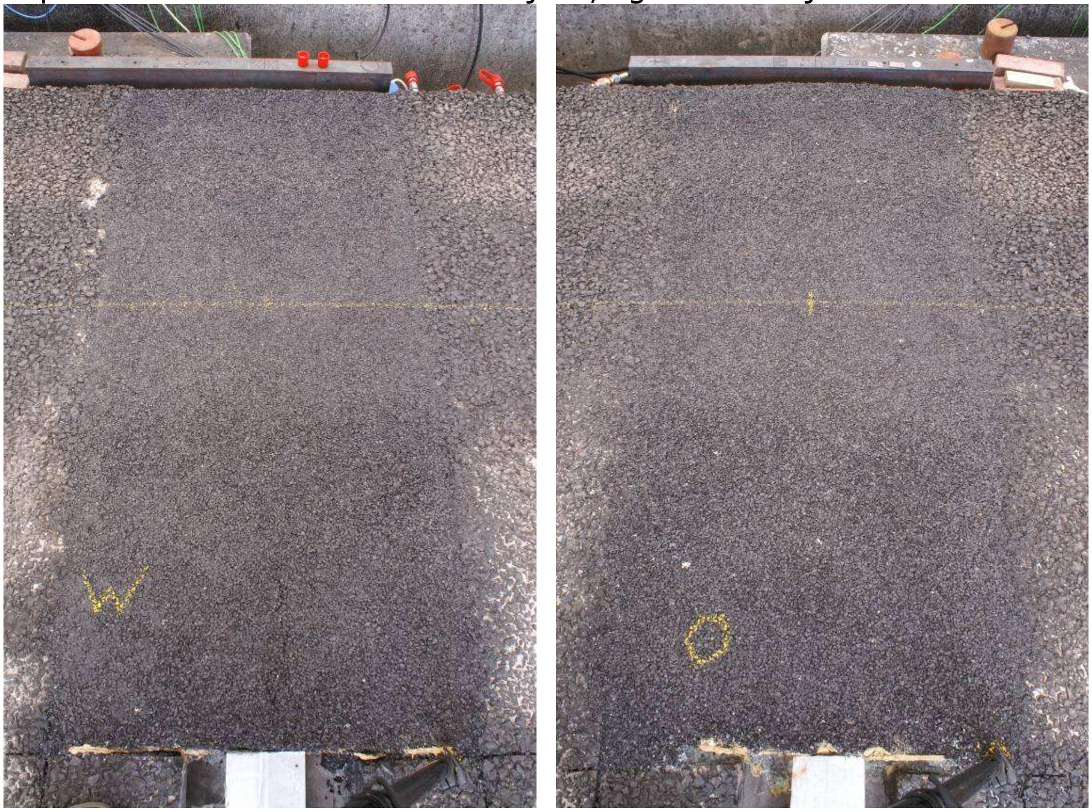
Rutting at N=80000. Left: +13 mm joint, right: -13mm joint.

Rutting at N=85000. Left: +13 mm joint, right: -13mm joint.

Top view at N=0. Left: +13mm joint, right: -13mm joint.

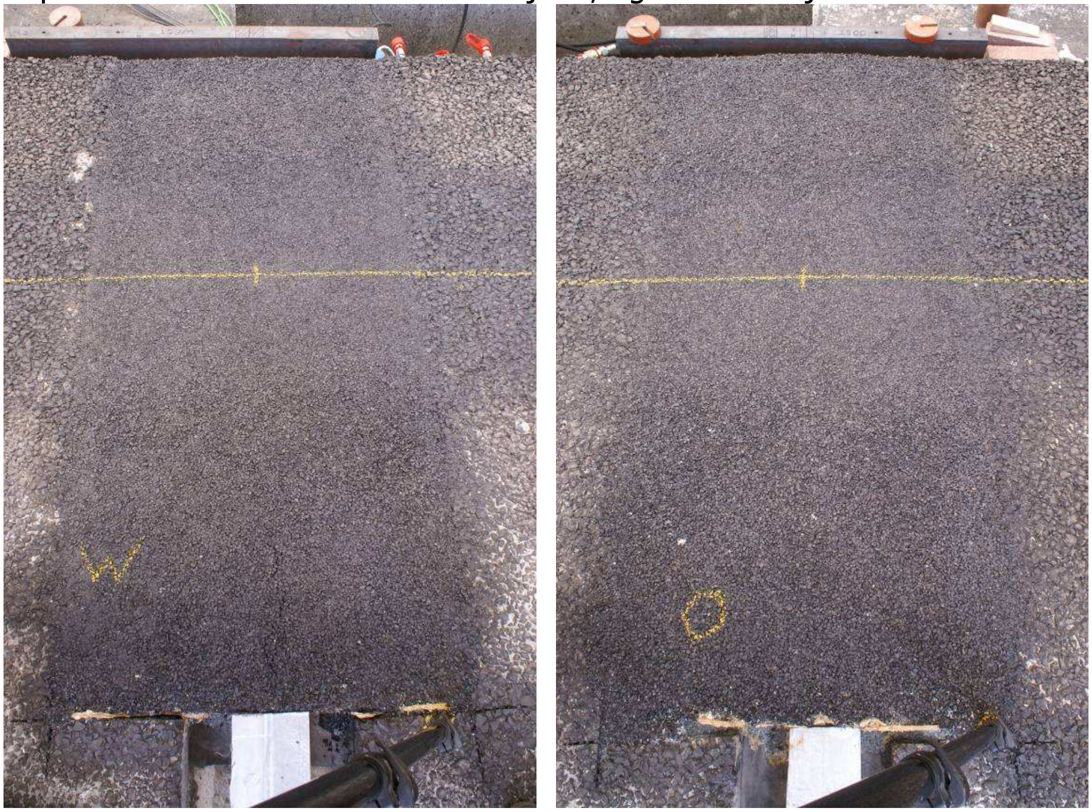


Top view at N=10000. Left: +13mm joint, right: -13mm joint.

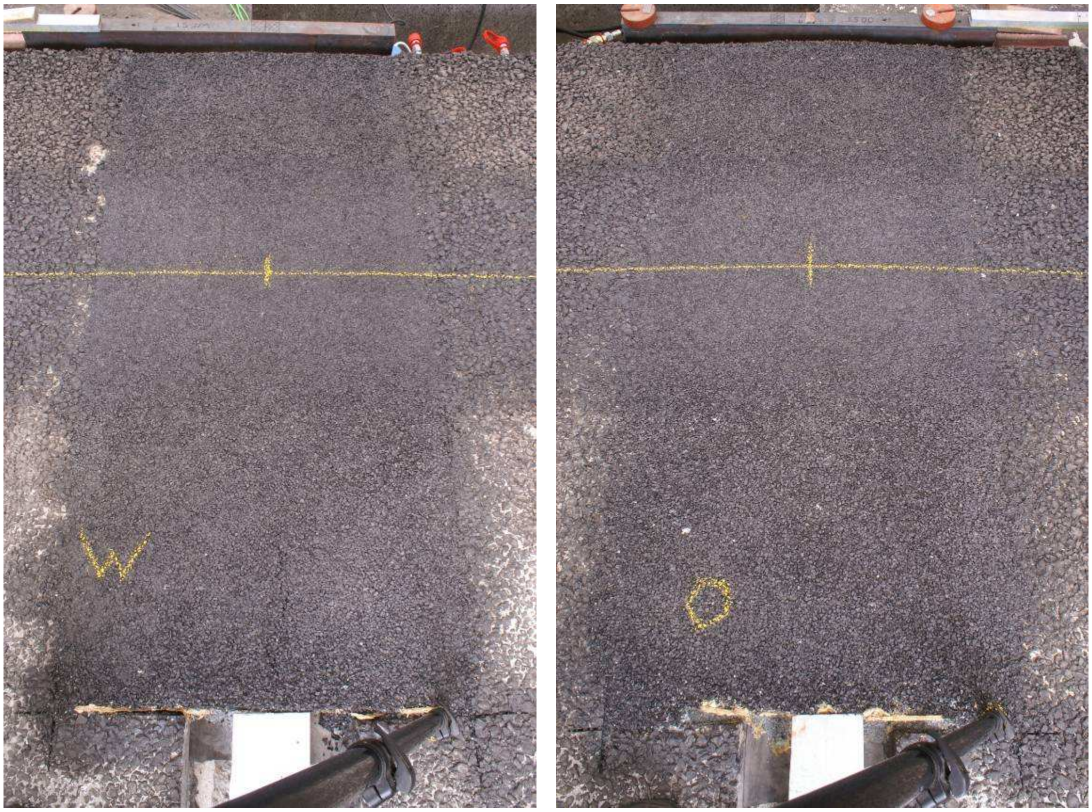


Top view at N=20000. Left: +13mm joint, right: -13mm joint.

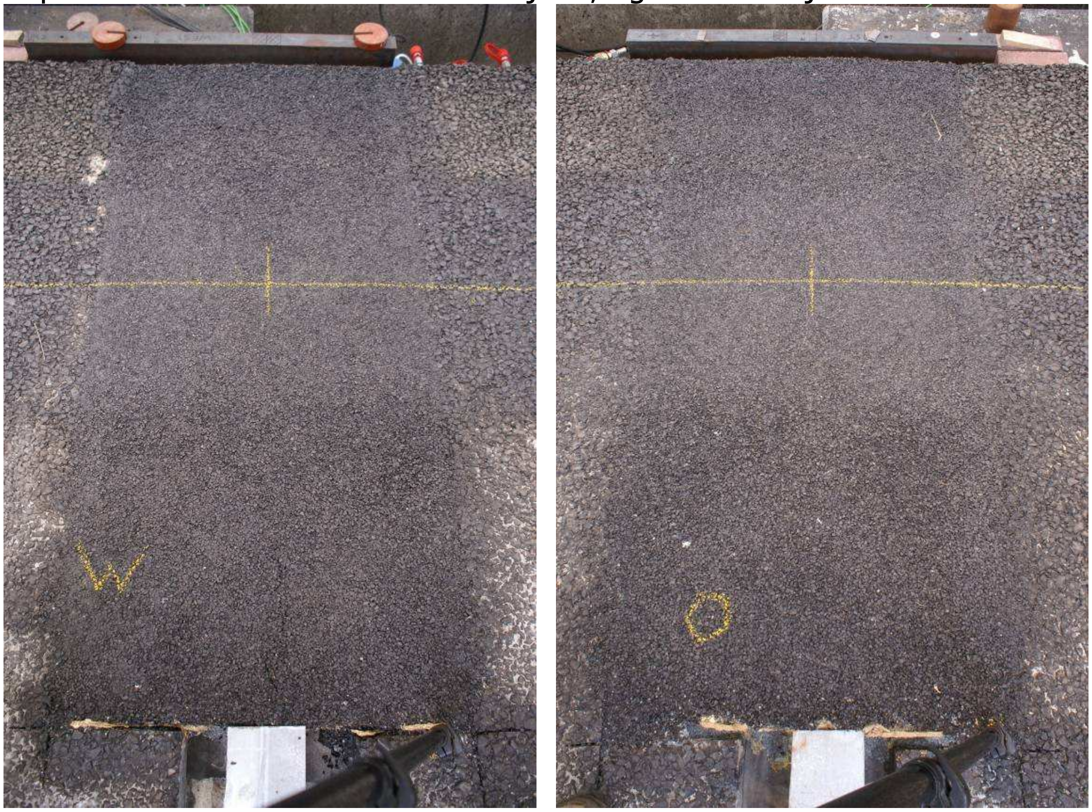
Top view at N=30000. Left: +13mm joint, right: -13mm joint.



Top view at N=40000. Left: +13mm joint, right: -13mm joint.



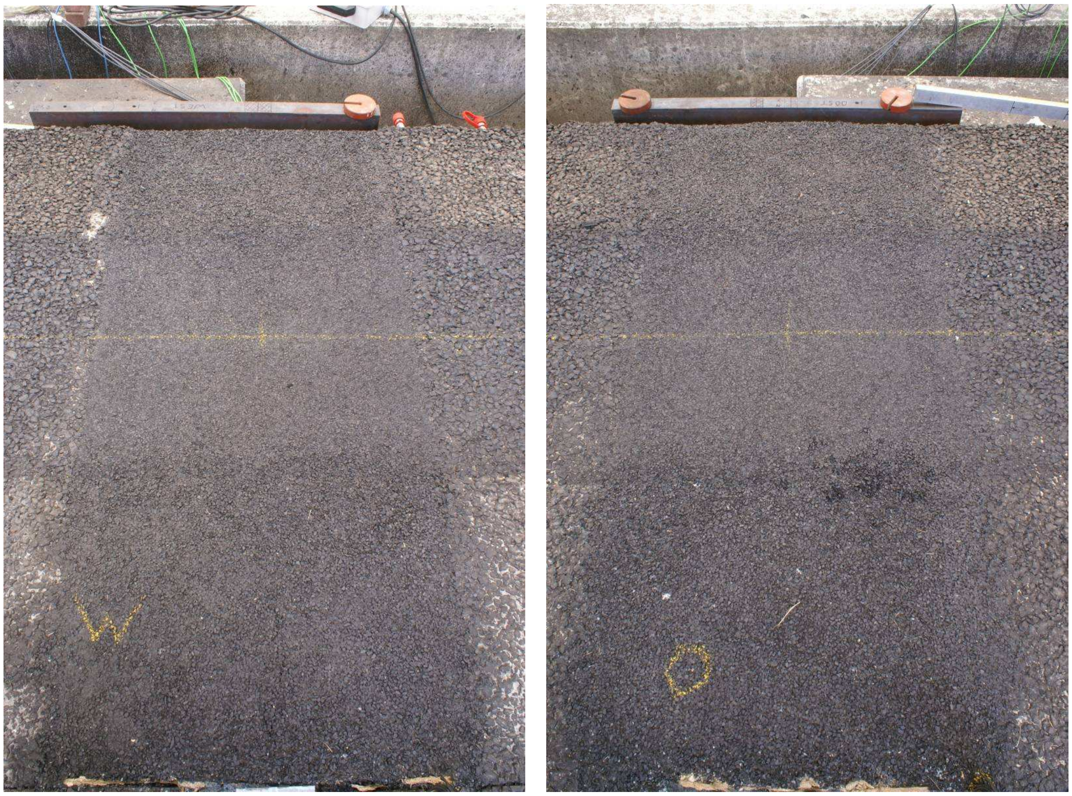
Top view at N=50000. Left: +13mm joint, right: -13mm joint.



Top view at N=60000. Left: +13mm joint, right: -13mm joint.

Top view at N=70000. Left: +13mm joint, right: -13mm joint.

Top view at N=80000. Left: +13mm joint, right: -13mm joint.



Top view at N=85000. Left: +13mm joint, right: -13mm joint.

Overview. Left: N=0, right: N=20000.

Overview. Left: N=30000, right: N=70000.

Overview. Left: N=80000, right: N=85000.

Appendix D
Semi static tension test

Tension test on the +13 mm joint


Left: t=0 s, u= +13.0 mm, Right: t= 480 s, u= 18.6 mm


Left: t=780 s, u= 29.0 mm, Right: t= 1020 s, u= 34.9 mm


Left: t=1200 s, u= 37.0 mm, Right: t= 1320 s, u= 39.1 mm


Left: t=1500 s, u= 44.5 mm, Right: t= 1920 s, u= 49.8 mm

Left: t=2280 s, u= 63.5 mm, Right: t= 2880 s, u= 91.28 mm

Tension test on the -13 mm joint


Left: t=0 s, u= -13.0 mm, Right: t= 8940 s, u= 13.7 mm


Left: t=10740 s, u= 20.3 mm, Right: t= 12540 s, u= 31.1 mm


Left: t=14460 s, u= 37.5 mm, Right: t= 16140 s, u= 45.7 mm


T=16860 s, u= 47.5 mm