Optimization of joint cutting positions in concrete roads using non-destructive measurement technology

Dipl.- Ing. Matthias Herold

MIT Mess- und Prüftechnik GmbH

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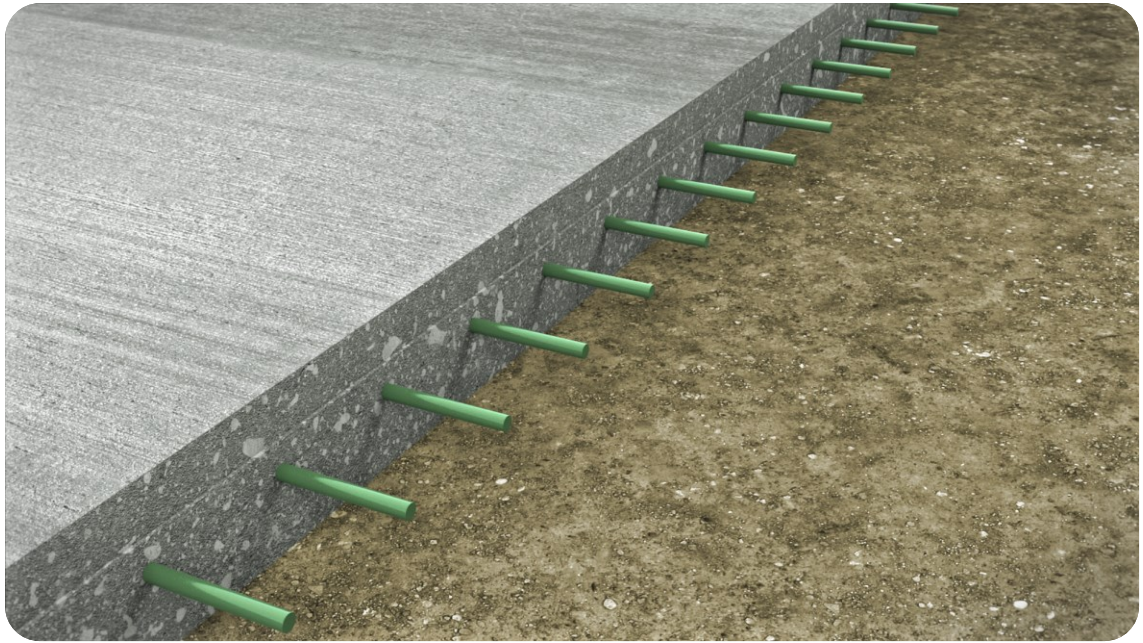
Function of dowels in transverse joints



Load transfer between adjacent concrete slabs

Ensuring that adjacent concrete slabs are at the same height

Allows plate movements (thermal expansion)

Specification for dowel position measurement in Germany

Specifications for:

- Depth
- Misalignment (horizontal rotation or vertical tilt)
- Side shift

9	Lage der Dübel	Schräglage ≤ 20 mm bezogen auf die Dübellänge von 500 mm Abweichung von der Höhenlage in Dübelmitte ≤ 20 mm Verschiebung senkrecht zur Fuge ≤ 50 mm

Nondestructive Dowel bar measurement devices

MIT-DOWEL-SCAN

MIT-SCAN2-BT

Nondestructive measurement report

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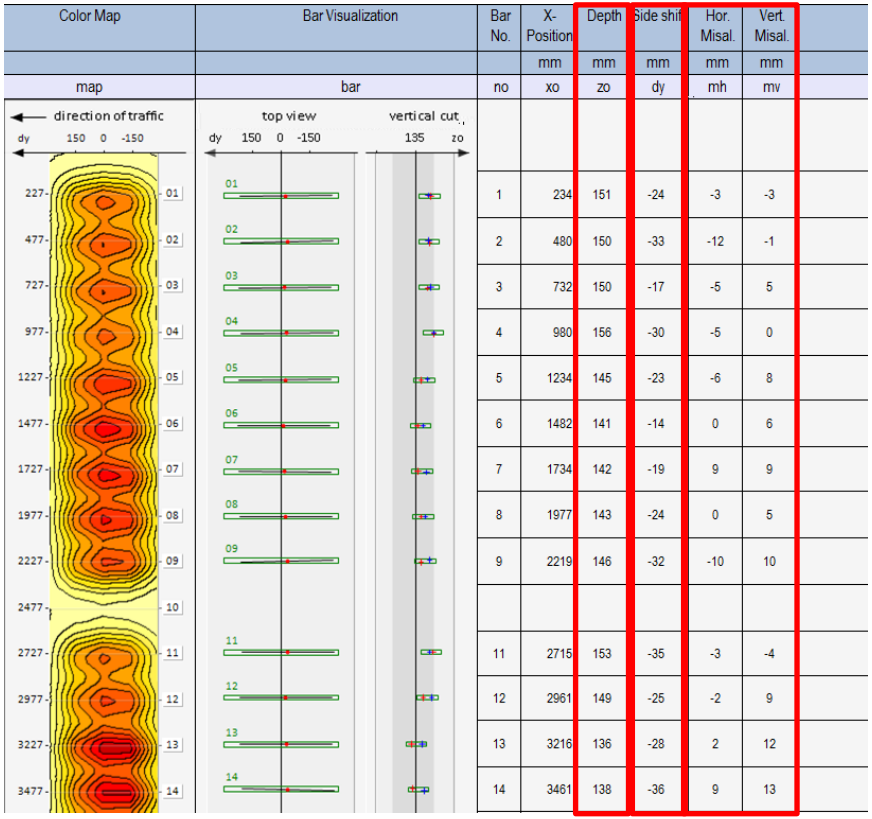
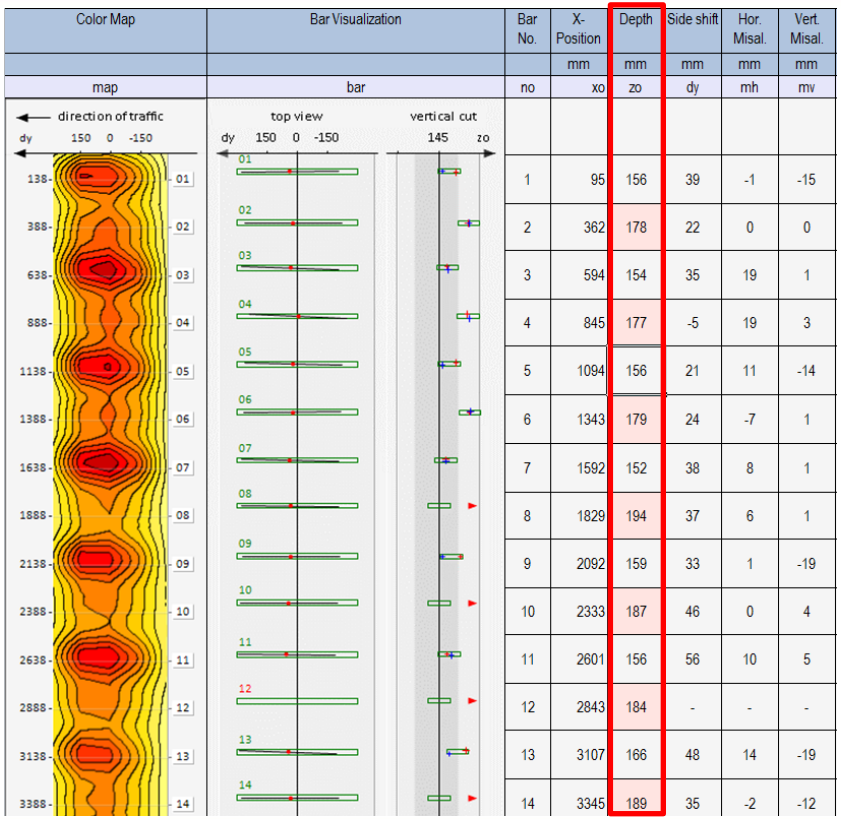


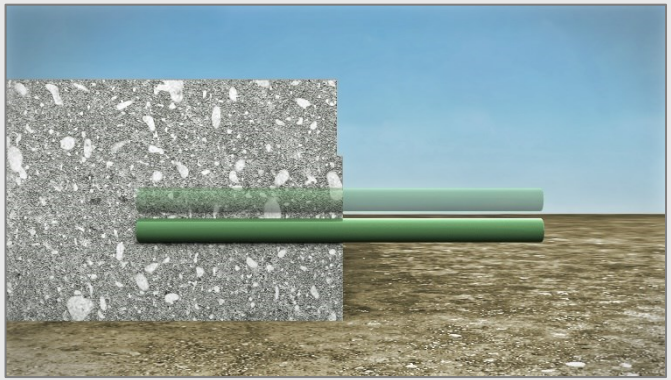
Bar No.	X-Position	Depth	Side shift	Hor. Misal.	Vert. Misal.
	mm	mm	mm	mm	mm
no	xo	zo	dy	mh	mv
1	234	151	-24	-3	-3
2	480	150	-33	-12	-1
3	732	150	-17	-5	5
4	980	156	-30	-5	0
5	1234	145	-23	-6	8
6	1482	141	-14	0	6
7	1734	142	-19	9	9
8	1977	143	-24	0	5
9	2219	146	-32	-10	10
11	2715	153	-35	-3	-4
12	2961	149	-25	-2	9
13	3216	136	-28	2	12
14	3461	138	-36	9	13

Typical installation errors and causes



Bar No.	X-Position	Depth	Side shift	Hor. Misal.	Vert. Misal.
	mm	mm	mm	mm	mm
map	bar	no	xo	zo	dy	mh	mv
1	95	156	39	-1	-15
2	362	178	22	0	0
3	594	154	35	19	1
4	845	177	-5	19	3
5	1094	156	21	11	-14
6	1343	179	24	-7	1
7	1592	152	38	8	1
8	1829	194	37	6	1
9	2092	159	33	1	-19
10	2333	187	46	0	4
11	2601	156	56	10	5
12	2843	184	-	-	-
13	3107	166	48	14	-19
14	3345	189	35	-2	-12

Typical installation errors and causes



Vertical displacement

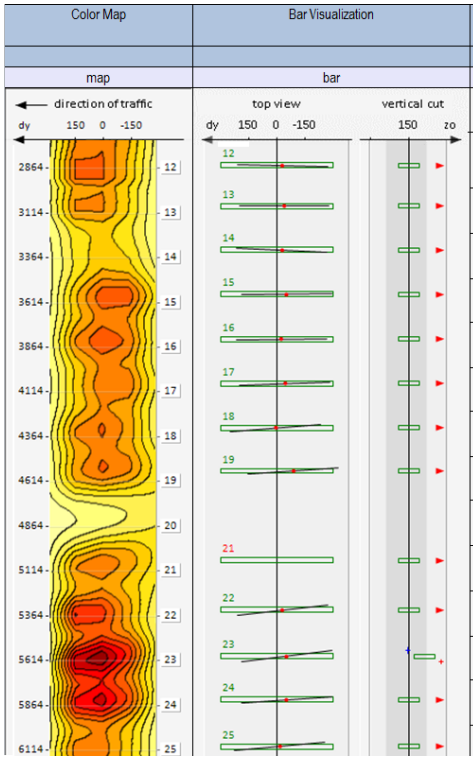
Consequences:

- Reduced load transfer
- Damaged dowels (cut or corrosion)

Causes:

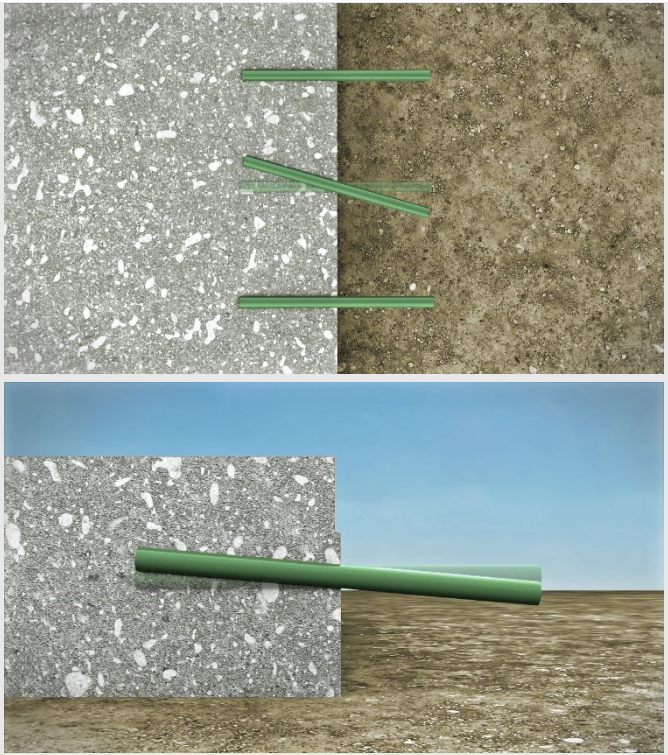
- Concrete consistency
- Vibration bottles
- DBI adjustment

Typical installation errors and causes



Bar No.	X-Position	Depth	Side shift	Hor. Misal.	Vert. Misal.
	mm	mm	mm	mm	mm
no	xo	zo	dy	mh	mv
12	2844	188	-30	11	-51
13	3073	198	-40	0	-57
14	3317	214	-26	21	-8
15	3563	174	-54	-7	5
16	3815	173	-24	-9	-7
17	4060	183	-44	-17	12
18	4307	181	8	-40	-9
19	4549	185	-91	-36	-47
21	5046	197	-105	-60	-75
22	5323	174	-30	-55	-56
23	5582	154	-54	-64	-39
24	5824	158	-53	-38	-35
25	6085	190	-17	-47	-47

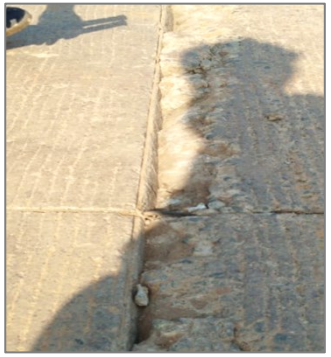
Typical installation errors and causes



Horizontal & vertical misalignment

Consequences:

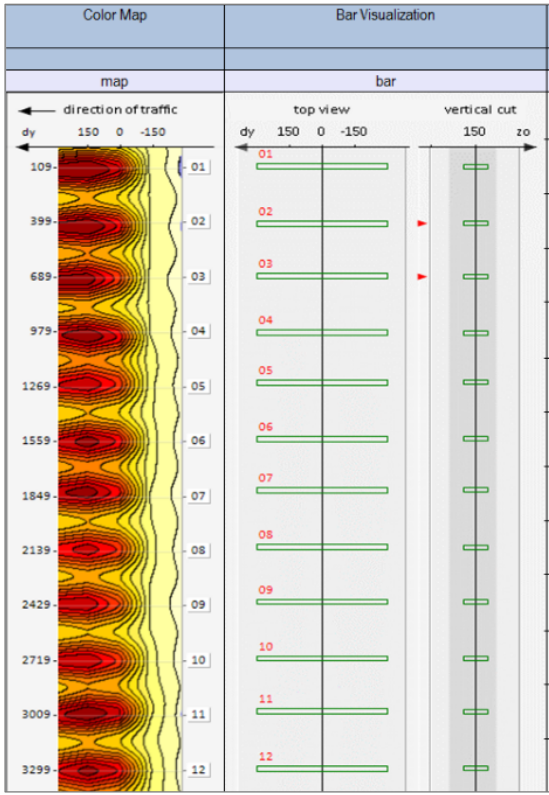
- Cracks
- Breakouts



Causes:

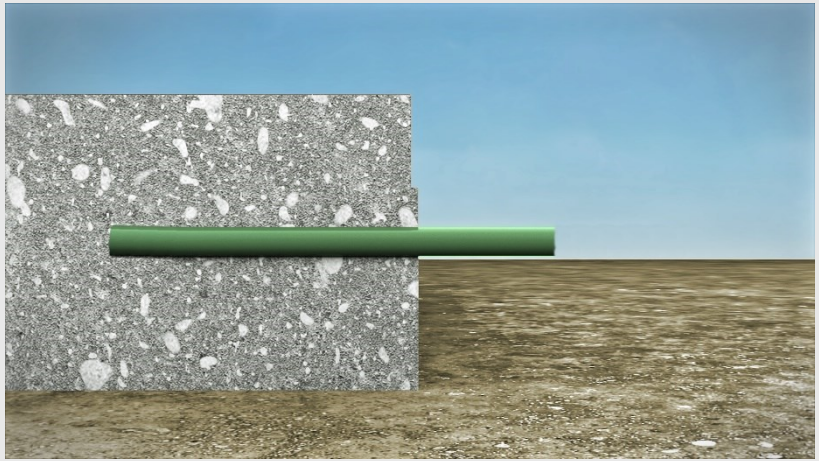
- Concrete consistency
- Vibration

Typical installation errors and causes



Bar No.	X-Position	Depth	Side shift	Hor. Misal.	Vert. Misal.
	mm	mm	mm	mm	mm
no	xo	zo	dy	mh	mv
1	101	124	191	-11	0
2	405	111	191	-8	1
3	683	112	195	-2	-10
4	982	125	177	5	-5
5	1243	129	172	-5	-6
6	1543	126	169	-5	-3
7	1813	127	178	-9	-4
8	2114	130	167	-1	0
9	2403	128	178	-3	-16
10	2703	128	161	-4	-11
11	2983	123	144	-20	-7
12	3286	126	145	-19	-6

Typical installation errors and causes



Side shift

Consequences:

- Reduced load transfer
- Differences in height

What are the causes lateral deviation of the dowels from the joint?

Process of joint cutting

1. Dowels (baskets) are set

2. Joint is marked

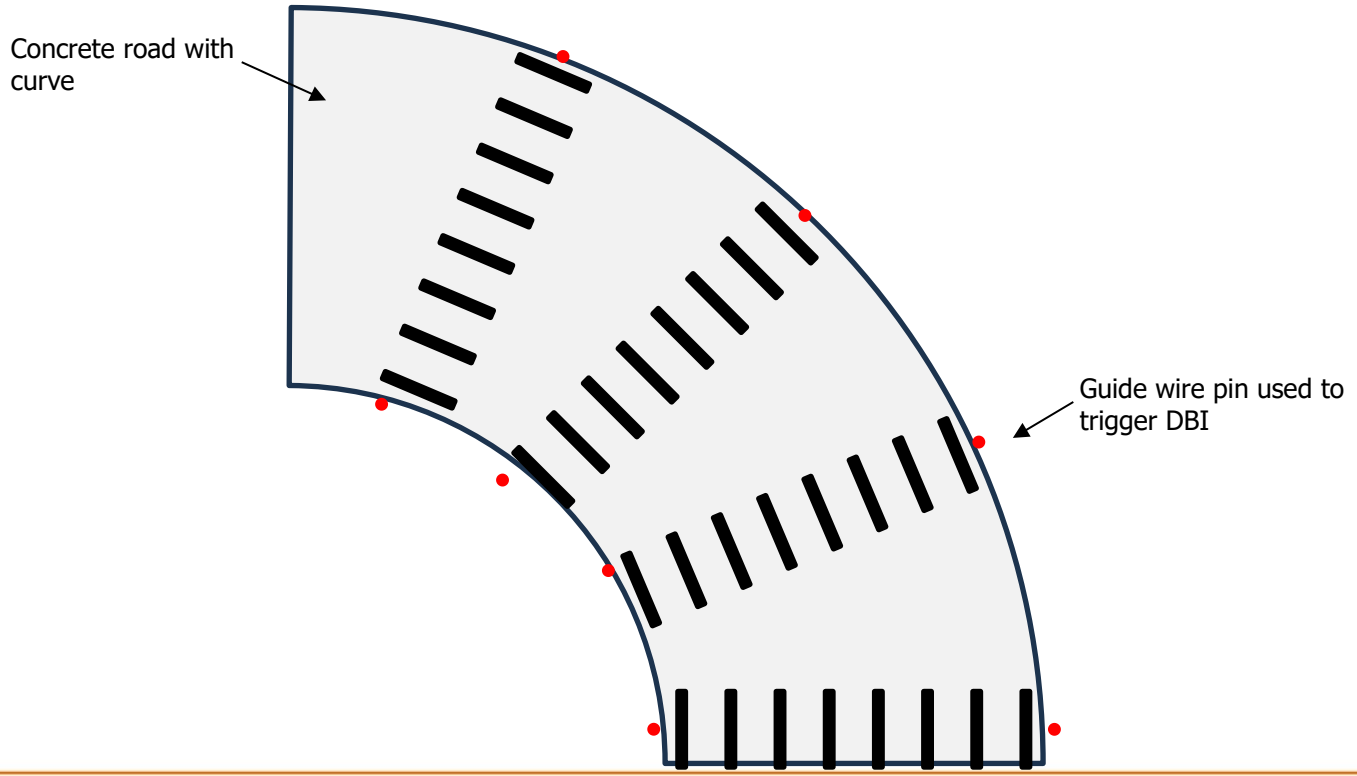
3. Joint is sawn

Process of joint cutting

Procedure for setting dowels with DBI:

Process	Possible influences
<u>DBI is triggered:</u> • Manually (pressing a button) • Automatically (guide wire pin)	• Short time span of two seconds • Operator distracted • Only visual orientation • Position of the switch
Concrete placement	(No movement of the dowel row) • Movement caused by vibration bottles

Guide wire pins within in a curve



Manual triggering

https://www.youtube.com/shorts/KiIxQ4xSM4A

Triggered by guide wire pin

Automatic marking

https://www.youtube.com/watch?v=kmo7oBKA6iI

Process of setting dowels

Procedure for setting dowels with baskets:

Process	Possible influences
Set basket	• Manual process with visual alignment only
Concrete placement	• Movement caused by vibrating bottles • Poorly anchored baskets

Basket installation

https://www.youtube.com/watch?v=7lxVcunUFqk

Process of joint marking

Joint marking:

Process	Possible influences
Orientation using the pin	• Pin may be missing
Orientation using a notch or color marking	• Inaccuracy due to manual setting • Inaccuracy due to the size of the color dot • Marking may be missing

Process of joint cutting

Process of joint cutting

Joint cut:

Process	Possible influences
Cut	Deviation of the cut from the mark (more likely to result in a minor error)

How common are such errors and how significant are the deviations?

Frequency of laterally displaced dowels

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Measurement data analysis:

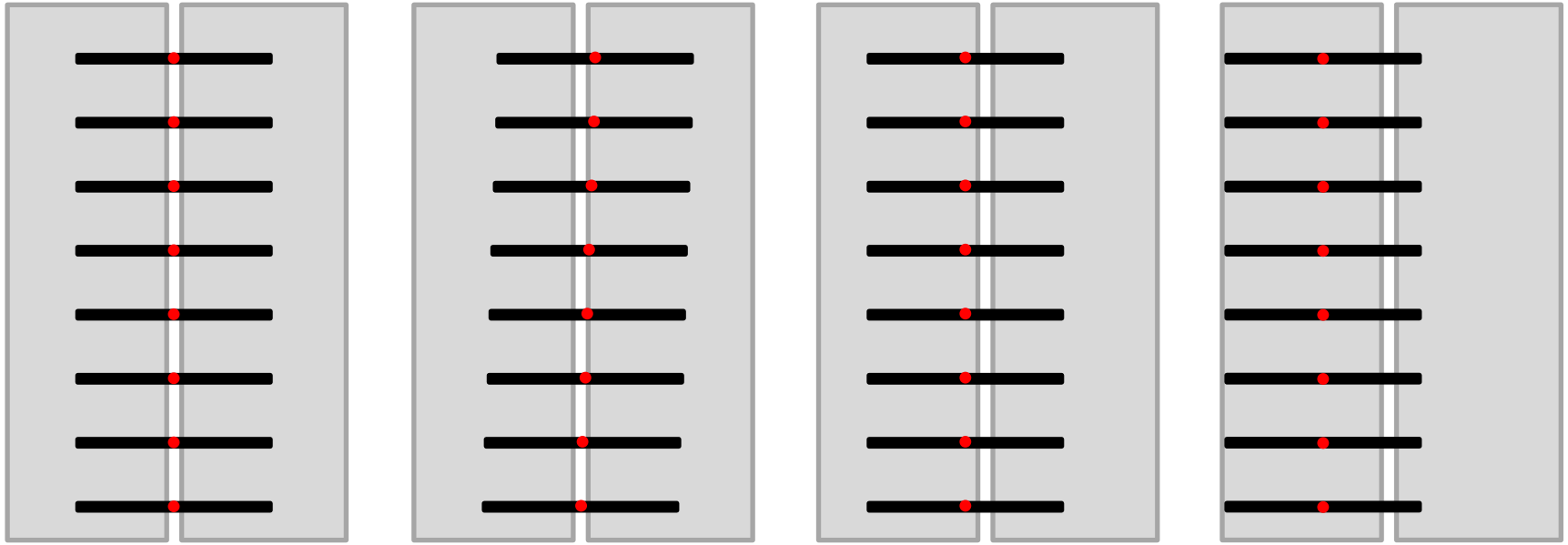
Basis:

- Evaluation of more than 10,000 dowel positions measured with MIT-DOWEL-SCAN or MIT-SCAN2-BT
- Installation method both with basket and DBI
- Countries: USA, Germany, Poland, Czech Republic

Unknown information:

- How has the marking been done?
- Which machines were used (which products of which manufacturers were involved)?
- How have the baskets ben anchored?
- Information about the situation, e.g. about a curve area?

Frequency of laterally displaced dowels



Within the tolerance (2 Inch)	One side outside the tolerance	Both sides outside the tolerance	Much more outside the tolerance (4 Inch)

Frequency of laterally displaced dowels

Within tolerance (2 Inch)	80 %
One-sided outside the tolerance	15 %
Both-sided outside the tolerance	5 %
Outside 4 Inch tolerance	3 %

- Most joints are within 2 Inch tolerance.
- One-sided outside is more often than both-sided.
- 3 % of the joints show a significant side shift.
- There are significant variations between companies and projects.
- Fixing the baskets is an issue.

Summary of causes

- Excessive lateral displacement of the dowels relatively to the joint can cause damage to the road.
- The number of faulty installations is not insignificant.
- The majority of the shown causes occurs before the chalk markings are applied.

These possible errors can be eliminated by determining the center of the dowels directly in front of the chalk mark.

MIT-JOINT-FINDER – new development

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Current development: MIT-JOINT-FINDER

- New device for marking dowels -> joints
- Non-destructive measurement of the center of the dowel bar
- Automatic marking of the center position with a color spray (dot setting)

MIT-JOINT-FINDER

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Simple handling:

- Moving the device across the dowels
- Stopping accordingly to the display, align briefly
- Spraying a point automatically – showing exactly the center of the measured dowel bar

MIT-JOINT-FINDER

Ensuring a correct joint cutting

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Advantages:

- Very little additional effort is required
- Compensate most of the deviations that have occurred in the past
- A simple and intuitive operation
- Independently of the dowel size
- Anchor and dowel marking is both possible
- Can be used for dowel settings as well as basket construction
- No calibration necessary

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Thank you very much for your attention.

Questions? Ideas?

MIT Mess- und Prüftechnik GmbH
Gostritzer Str. 63
01217 Dresden/ Germany
Phone: +49 (0) 351 87181-44
matthias.herold@mit-dresden.de
www.mit-dresden.de