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Report

Results

CROW CPX Round Robin Test 2020

Colophon

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Summary

The CPX (Close-ProXimity)-method is a method to measure the influence of road surfaces on traffic noise. In the Netherlands, these measurements are typically performed using a trailer towed by a vehicle. ISO 11819-2 describes the method, the requirements and analysis of the data.

In an effort to reduce the spread in CPX-measurement results in the Netherlands, a CPX protocol for admission and round robin test of CPX-devices was made in 2017 under the auspices of CROW, Platform Road Measurements. This protocol was updated in March 2020.

On September 16th, 2020 a CPX round robin test was performed in the Netherlands. In total there were eight participants. The results of the evaluation per participant are shown in the table below. The compliance of the measurement results with the requirements in the protocol are quantified by the parameters A, B, and C. Where the 'A' value determines the average of the SPL-differences per 100 m section (systematic error), 'B' is the standard error of the differences for all 100 m sections (indication of random error), 'C' is the RMS of the differences for all 100 m sections (indication of repeatability).

participant	SMA-NL 11B			DLPAC		
	A [dB]	B [dB]	C [dB]	A [dB]	B [dB]	C [dB]
CPX01	0,59	0,10	0,10	0,58	0,13	0,10
CPX02	0,09	0,18	0,10	0,38	0,17	0,17
CPX03	0,12	0,12	0,11	0,47	0,15	0,10
CPX04	0,15	0,10	0,10	0,13	0,14	0,12
CPX05	0,14	0,10	0,09	0,23	0,11	0,10
CPX06	0,37	0,15	0,14	0,32	0,11	0,12
CPX07	0,43	0,10	0,09	0,24	0,10	0,09
CPX08	0,19	0,17	0,13	0,52	0,14	0,12
requirement protocol	≤ 1,0	≤ 0,5	≤ 0,5	≤ 1,0	≤ 0,5	≤ 0,5

Each CPX-system should meet on both road surface types the requirements for the parameter A, B and C. All CPX-systems meet the requirements of the protocol.

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1 Introduction

The CPX (Close-ProXimity)-method is a method to measure the influence of road surfaces on traffic noise. Measurements are typically performed using a trailer under conditions where tyre/road noise is dominant. ISO 11819-2 [1] describes the method, the requirements and analysis of the data. This report describes the results of the round robin test of CPX-devices that was conducted on September 16th, 2020 under auspices of CROW, Platform Road Measurements in the Netherlands.

In an effort to reduce the spread in CPX-measurement results in the Netherlands, a CPX protocol for admission and round robin test of CPX-devices [2] has been developed. The goal of the protocol is to minimize the spread in measurement results, while still being practically feasible. In the protocol requirements are specified for the instrumentation, the maximum spread and mutual differences of the results of the CPX-systems that participate in the round robin test.

In 2008 [3], 2011 [4] and 2017 [5] also similar CPX round robin tests have been performed in the Netherlands.

2 Test program

2.1 Objective

The objective of the CPX round robin test is to reduce and minimize the spread in CPX-results in the Netherlands. The CROW Protocol for admission and round robin test of CPX devices [2] describes how to achieve this.

The compliance of the measurement results with the requirements in the protocol are quantified by the parameters 'A', 'B', and 'C':

- 'A' is the average of the SPL-differences per 100 m section (systematic error)
- 'B' is the standard error of the differences for all 100 m sections (indication of random error)
- 'C' is the RMS of the differences for all 100 m sections (indication of repeatability)

2.2 Test set-up

The CPX-measurements shall be performed according to ISO 11819-2. In limitation of the options in ISO 11819-2, a Dutch requirement is that CPX-trailers shall be constructed as two-wheeled trailers. The test wheels shall roll in the left and right wheel tracks of the traffic lane. The axle track of the test wheels shall correspond as close as possible to the distance between the wheel tracks on the lane and shall measure $1,90 + 0,10$ m between the center lines.

2.3 Test conditions

The CPX round robin test was conducted on September 16th, 2020 between 10 am and 3 pm. It was a sunny day with a maximum air temperature around 24°C and a maximum road surface temperature around 30°C. This all fits within the temperature requirements of ISO 11819-2.

All participants performed measurements on all road sections. Instead of the minimum prescribed three measurement runs on each road section, all participants performed six measurement runs per road section.

2.4 Test tyre

The measurements were performed using the Standard Reference Test Tyre (SRTT) as described in ISO/TS 11819-3 [6]. Each participant used their own set of SRTT tyres. No measurements were performed with the Avon AV4 tyres.

2.5 Specification and calibration of instrumentation

By participating in the CPX round robin test 2020 each participant has declared that their CPX-system complies with the requirements according to ISO 11819-2.

2.6 Organisation

The CPX round robin test was conducted under auspices of CROW, Platform Road Measurements. On behalf of the organising panel Mr. W.J.A van Vliet of the Dutch National Road Authority was in charge as supervisor.

3 Test locations

3.1 General

According to the CROW protocol [2] the measurements should be performed on an open and dense road surface with at least 1000 m length. The reference speed for the measurements is 80 km/h. Both road surface types should have a good acoustic homogeneity (standard deviation not more than 0,5 dB(A)).

3.2 Test sites

Close to the office of the local road district of the province Gelderland in Warnsveld two road sections were selected:

- Double Layered Porous Asphalt Concrete (DLPAC) on the N314 near Zutphen, between km 29.70 – 30.68
- Stone Mastic Asphalt (SMA-NL 11B) on the N348 near Brummen between km 22.10 – 22.70

The acoustic homogeneity (in driving direction) of the DLPAC and SMA sections was checked beforehand, and found to be less than 0,5 dB(A). More information about the road sections can be found in Appendix B.

3.2.1 Safety

On the day the CPX round robin test took place, it was decided to reduce the length of the DLPAC road section to 900 m. This was due to safety reasons and decided after consultation and agreement of the supervisor. All participants also agreed with the reduction of the length.

4 Participants CPX RRT 2020

In total eight CPX-systems participated in the CPX round robin test on September 16th, 2020. In figure 1 a photo of the measurement systems is shown. Seven CPX-trailers have an enclosure and one had no enclosure. Below also pictures are shown of the CPX-trailer of each participant. Names and addresses of the participants are listed in Appendix A.



figure 1

*CPX-measurement systems that participated in the round robin test 2020
(left to right: Vlaamse Overheid, AIT, OMWB, M+P (trailer 02), G+P, M+P (trailer 04) and BRRC).
Not in the figure CPX-system of DGMR*



Vlaamse Overheid Agentschap Wegen en Verkeer
Belgium



Austrian Institute of Technology (AIT)
Austria



Omgevingsdienst Midden- en West-Brabant (OMWB)
Netherlands



M+P
Netherlands



G+P
Switzerland



M+P
Netherlands



Belgian Road Research Center (BRRC)
Belgium



DGMR
Netherlands

5 Analysis

5.1 Compliance with requirements in protocol

5.1.1 General

The CPX round robin protocol of CROW describes how the analysis of compliance should be performed. The analysis is done on A-weighted overall sound pressure levels (SPL) in dB(A) per hm-section. The SPL values are analysed per individual measuring run, and not averaged over two runs into a formal CPX value according to ISO 11819-2.

5.1.2 Trueness and precision

The CPX-results are assessed based on trueness and precision. The procedure is outlined in detail in the protocol. A shorter description concerning the meaning of the parameters 'A', 'B' and 'C' is given below.

The parameters 'A', 'B' and 'C' quantify the spread in measurement results and are used to check the compliance with the protocol. A fictive example of measurements over a length of 500 m is shown in figure 2. The black line represents the group average per 100 m section (hm-section). The other lines indicate the results of three measurement runs performed by one measurement device "Z". Other measurement devices are not shown. In this example the device Z has a small average difference with respect to the reference (small 'A'), but relatively large variation in differences with respect to the reference (large 'B'). The variation is not caused by accidental variations between repeated measurement runs, because this variation is smaller (small 'C').

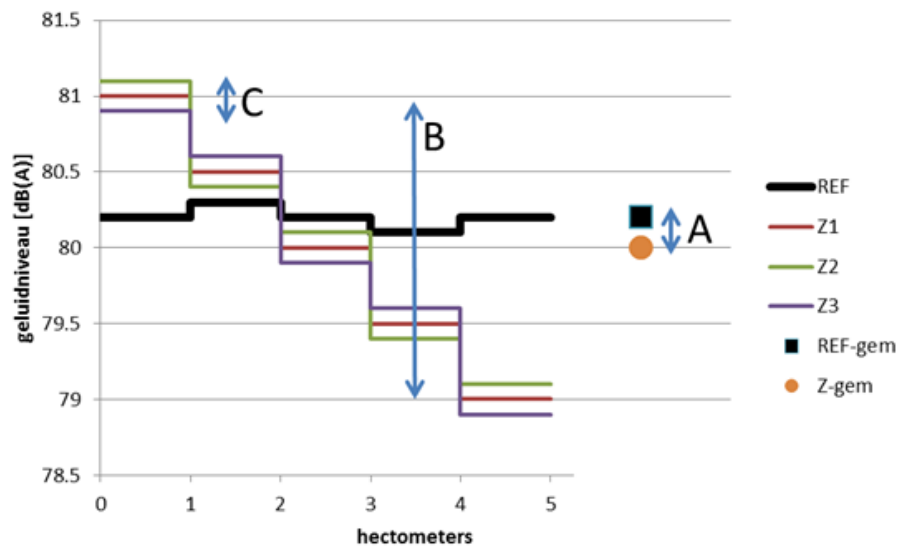


figure 2 Explanation of A,B and C parameters in CPX protocol round robin test

5.1.3 Results

The CPX-results were evaluated following the steps outlined in the protocol.

The first step is the determination of the reference value ('group average') of each hm section of road section. This analysis showed that no CPX-data of a hm section needs to be excluded to determine the reference value.

The results of determination of the parameters 'A', 'B' and 'C' are shown in table I. To be able to see the differences between the CPX-systems in more detail the value of the parameter 'A' is not presented as an absolute value as required according to the protocol.

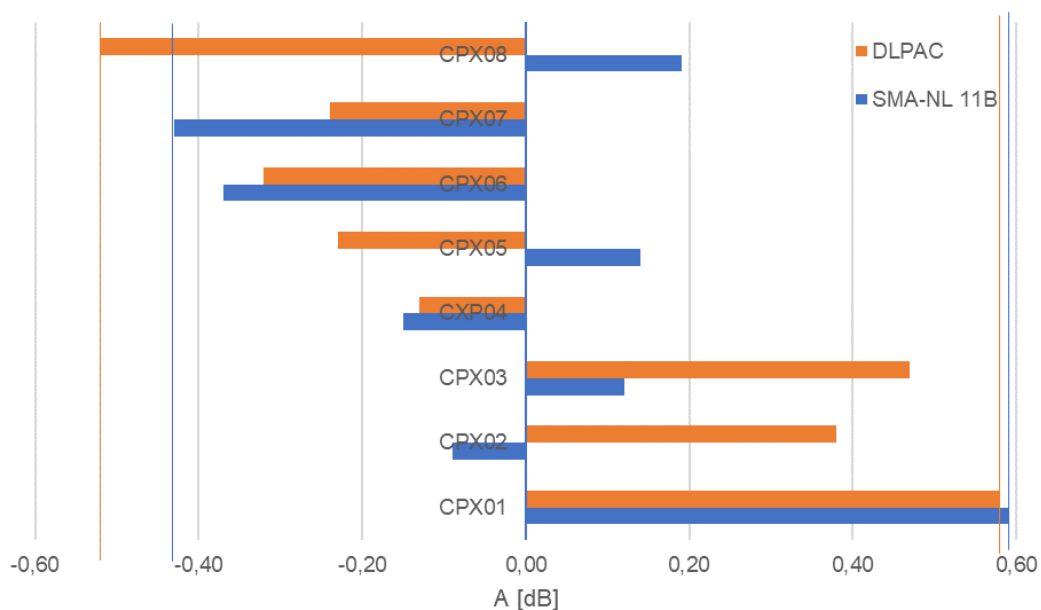
In Appendix C the results of the CROW CPX RRT in 2017 [5] are shown.

table I

Evaluation of CPX-results per participant. The 'A' value determines the average of the SPL-differences per 100 m section (systematic error), 'B' is the standard error of the differences for all 100 m sections (indication of random error), 'C' is the RMS of the differences for all 100 m sections (indication of repeatability)

participant	SMA-NL 11B			DLPAC		
	A [dB]	B [dB]	C [dB]	A [dB]	B [dB]	C [dB]
CPX01	0,59	0,10	0,10	0,58	0,13	0,10
CPX02	-0,09	0,18	0,10	0,38	0,17	0,17
CPX03	0,12	0,12	0,11	0,47	0,15	0,10
CPX04	-0,15	0,10	0,10	-0,13	0,14	0,12
CPX05	0,14	0,10	0,09	-0,23	0,11	0,10
CPX06	-0,37	0,15	0,14	-0,32	0,11	0,12
CPX07	-0,43	0,10	0,09	-0,24	0,10	0,09
CPX08	0,19	0,17	0,13	-0,52	0,14	0,12
requirement protocol	$\leq 1,0$ *)	$\leq 0,5$	$\leq 0,5$	$\leq 1,0$ *)	$\leq 0,5$	$\leq 0,5$
min	-0,43	0,10	0,09	-0,52	0,10	0,09
max	0,59	0,18	0,14	0,58	0,17	0,17
range (max-min)	1,02	0,08	0,05	1,10	0,07	0,08
stdev	0,33	-	-	0,41	-	-

*) absolute value of parameter A



6 Conclusions

The current CPX round robin test was the second test according to the CROW protocol in the Netherlands. Everything went well and the participants were able to perform the measurements almost simultaneously within the given time frame. Also the three additional measurement runs (total six runs instead of three) fits within the time schedule. Due to safety reasons the supervisor and all participants agreed to reduce the length of the DLPAC to a total length of 900 m. According the CPX-protocol a minimum length of 1000 m is required.

The analysis of compliance shows the following:

- All participants fulfil the requirements regarding systematic error ('A' parameter)
- All participants fulfil the requirements regarding random error ('B' parameter)
- All participants fulfil the requirements regarding repeatability ('C' parameter)

7 References

- [1] ISO 11819-2, "Acoustics – Measurement of the influence of road surfaces on traffic noise - Part 2: The close-proximity (CPX) method", March 2017;
- [2] "CROW Protocol for admission and round robin test of CPX devices", Report CROW D20, March 2020;
- [3] "Ringonderzoek CPX-meetaanhangers – Analyse van de resultaten", Report MON-RPT-033-DTS-2009-00414, TNO, June 22nd, 2009;
- [4] "CPX trailer comparison round robin test data analysis", Report CROW D12-02, CROW, May 2012;
- [5] "Results CPX Round Robin Test 2017", Report M+P.CROW.17.01.1, September 7th, 2017;
- [6] ISO/TS 11819-3, "Acoustics – Measurement of the influence of road surfaces on traffic noise - Part 3: Reference tyres", March 2017.

Appendix A

Participants

Participants

List of participants.

Participant	Country	CPX make	CPX model
Vlaamse Overheid Agentschap Wegen en Verkeer www.wegenenverkeer.be	BE	-	enclosure
Austrian Institute of Technology www.ait.ac.at	AT	-	enclosure
Omgevingsdienst Midden- en West-Brabant www.omwb.nl	NL	-	enclosure
M+P www.mp.nl	NL	M+P 04	enclosure
G+P www.gundp.ch	CH		enclosure
M+P www.mp.nl	NL	M+P 02	enclosure
Belgian Road Research Centre www.brrc.be	BE		enclosure
DGMR www.dgmr.nl	NL	-	no enclosure

Appendix B

Test locations

Test locations

Close to the office of the local road district of the province Gelderland in Warnsveld two road sections were selected:

- Double Layered Porous Asphalt Concrete (DLPAC) on the N314 near Zutphen, between km 29.70 – 30.68
 - eastbound
 - maximum allowed speed is 80 km/h
 - length of road section is 1020 m
 - construction date: July 2014
- Stone Mastic Asphalt (SMA-NL 11B) on the N348 near Brummen between km 22.10 – 22.70
 - north- and southbound
 - maximum allowed speed is 100 km/h (passenger cars) and 80 km/h (trucks)
 - length of road section is 2x 600 m
 - construction date: July 2013

In figure 3 the locations of the road sections is shown. Both road sections are straight with no bends.

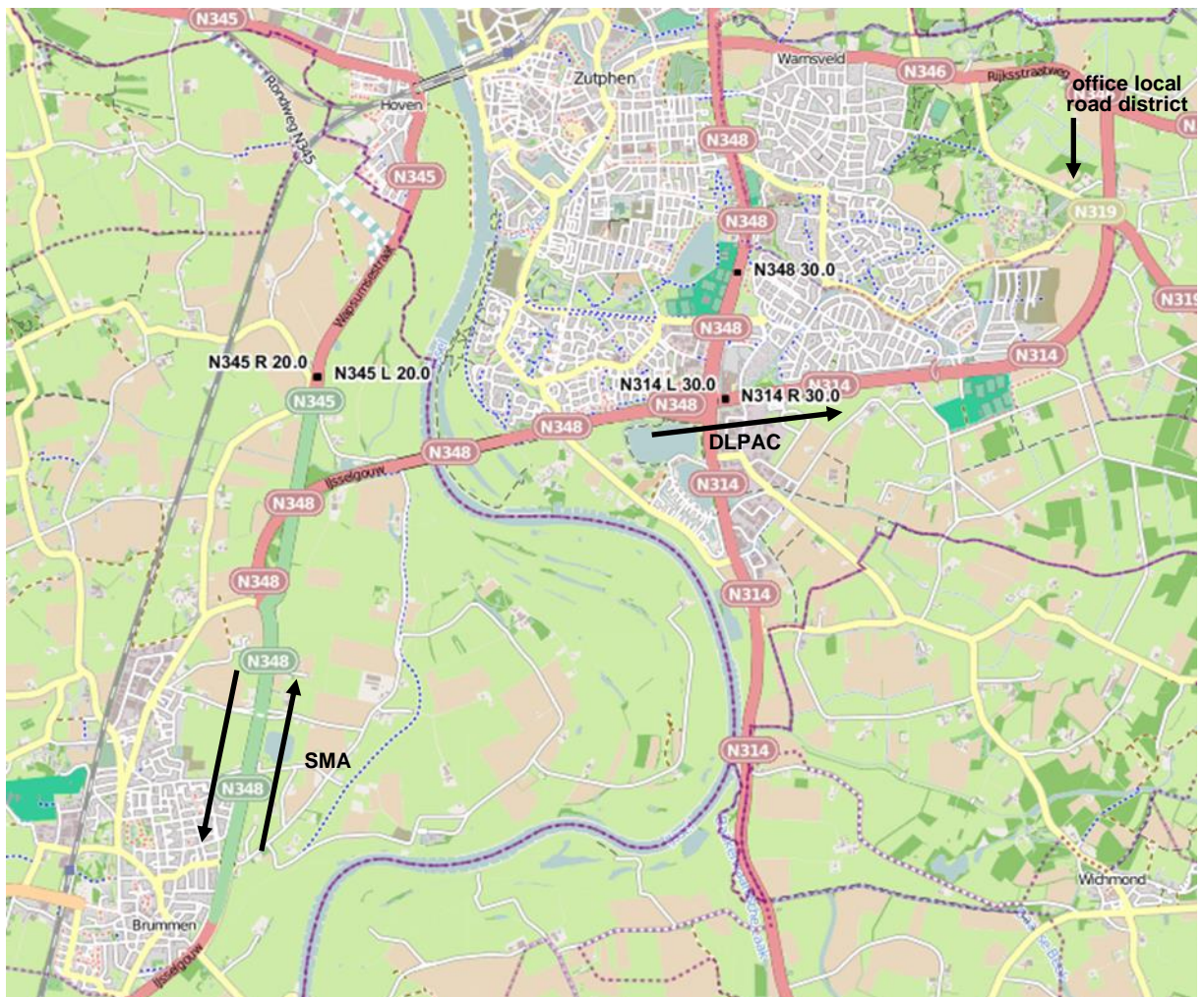


figure 3

Location DLPAC on the N314 Zutphen and SMA on the N348 Brummen

Appendix C

Results CROW CPX RRT 2017

Results CROW CPX RRT 2017

The previous CPX RRT in the Netherlands under auspices of CROW, Platform Road Measurements took place in September 2017 [5]. In total nine CPX-systems participated in the CPX round robin test 2017. Six of these CPX-systems participated also in the CPX RRT 2020. The test locations in 2017 and 2019 were the same. In table II the results of the CPX RRT 2017 are shown. On the results the tyre rubber hardness correction has been applied.

table II Results of the CROW CPX RRT in 2017 including tyre rubber hardness correction

participant	SMA-NL 11B			DLPAC		
	A [dB]	B [dB]	C [dB]	A [dB]	B [dB]	C [dB]
CPX01_2017	0,05	0,13	0,12	-0,24	0,12	0,09
CPX02_2017	-0,05	0,12	0,11	-0,86	0,11	0,08
CPX03_2017	0,56	0,17	0,15	0,73	0,13	0,10
CPX04_2017	-1,04	0,27	0,20	-0,74	0,25	0,23
CPX05_2017	0,40	0,13	0,12	0,05	0,09	0,07
CPX06_2017	-0,08	0,13	0,12	0,41	0,12	0,09
CPX07_2017	-0,58	0,21	0,21	-1,26	0,16	0,14
CPX08_2017	0,12	0,24	0,22	0,23	0,11	0,11
CPX09_2017	-0,22	0,11	0,09	0,40	0,11	0,10
requirement protocol	$\leq 1,0$ *)	$\leq 1,3$	$\leq 0,5$	$\leq 1,0$ *)	$\leq 1,3$	$\leq 0,5$
min	-1,04	0,11	0,09	-1,26	0,09	0,07
max	0,56	0,27	0,22	0,73	0,25	0,23
range (max-min)	1,60	0,16	0,12	1,99	0,16	0,16
stdev	0,49	-	-	0,68	-	-

*) absolute value of parameter A

