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TNO report

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Monitoring Network Building Vibrations - Analysis Earthquake 08-01-2018 (Zeerijp)

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Contents

1 Introduction

1.1 Background

ln Groningen, so-called induced earthquakes occur, as a result of the extraction of natural gas. These earthquakes cause ground-borne vibrations that transfer to the foundations of buildings thus causing the building itself to vibrate. These vibrations may result in damage to the building.

To determine the effects of the induced earthquakes, NAM has set up a research program. Part of this research program is a monitoring network for building vibrations. In about 350 buildings, a vibration sensor is installed, measuring continuously the building vibrations at the foundation level. To gain insight in the vulnerability of the buildings in Groningen for particular vibration levels, this monitoring network is accompanied with damage survey. By surveying the damage in these buildings before and after an earthquake, a relation can be found between the building vibrations due to an earthquake and the damage in the buildings caused by that earthquake.

TNO has designed and built this monitoring network for building vibrations, including an IT infrastructure to handle, process and analyse the data (the vibration data centre). The set-up of this monitoring network is described in TNO-report 2015 R10501 “Monitoring Network Building Vibrations” [ref 01].

1.2 Purpose

On January 8th 2018, an earthquakes took place at Zeerijp. According to the website of KNMI the characteristics of this earthquakes are:

- Name: Zeerijp
- Date: 8th January 2018
- Time: 14:00h (UTC)
- Magnitude: M = 3.4
- Location epicentre (latitude/longitude): 53.363 ° N / 6.751 ° E
- Location epicentre (X-Y): 245789, 598262 m N
- Depth: 3.0 km

NAM has commissioned TNO to analyse the effects of this earthquake on the buildings of the monitoring network. These effects comprise the building vibrations and the damage inflicted on the buildings due to the earthquake vibration.

1.3 Guide

This report describes the results of the analysis of the earthquake.
Firstly, Chapter 2 provides a general description of the set-up of the monitoring network building vibrations. Subsequently, Chapter 3 gives an overview of the buildings for which the measured vibration velocity at foundation level has exceeded a pre-set trigger value.

The analysis of the building vibrations is given in Chapter 4 – 5. Chapter 4 describes the framework of this analysis and Chapter 5 presents an analysis of the building vibrations.
The analysis of the building damage, caused by the earthquake, is given in Chapter 6 – 8. Chapter 6 describes the framework of this analysis, Chapter 7 gives the results of the repetitive damage surveys and Chapter 8 the damage curves.
Finally, Chapter 9 to 11 give the conclusions, references and the signature.

1.4 Former reports

This report is the 5th report of the Monitoring Network Building Vibrations with an analysis of the effects of the earthquakes. The former reports were:

- TNO report 2015R10604 “Monitoring Network Building Vibrations – Analysis Earthquake 30-09-2014 Garmerwolde” [ref 04].
- TNO report 2015R10604 “Monitoring Network Building Vibrations – Analysis Earthquakes 05-11-2014 (Zandeweer), 30-12-2014 (Woudbloem) and 06-01-2015 (Wirdum)” [ref 05].
- TNO report 2016R10421 “Monitoring Network Building Vibrations – Analysis Earthquake 30-09-2015 Hellum” [ref 06].
- TNO-report 2018 R10275 “Monitoring Network Building Vibrations – Analysis Earthquakes 27-05-2017 (Slochteren)” [ref 07].

On 31 July 2018 a former version (version A) of this report was made available for the participants of this Monitoring Network. In this version (version B) a Dutch translation of the conclusions is added to Chapter 9.

2 Set-up of the analysis procedures of the monitoring network

The analysis procedure of the monitoring network is based on the path the vibrations travel from source to building. The path the vibrations travel comprises of (Figure 2.1):

1. Ground-borne vibrations caused by an earthquake which spread towards the surroundings.
2. Ground-borne vibrations are transferred to the buildings and result in vibration loads on the building foundations.
3. Building vibrations that can cause damage.

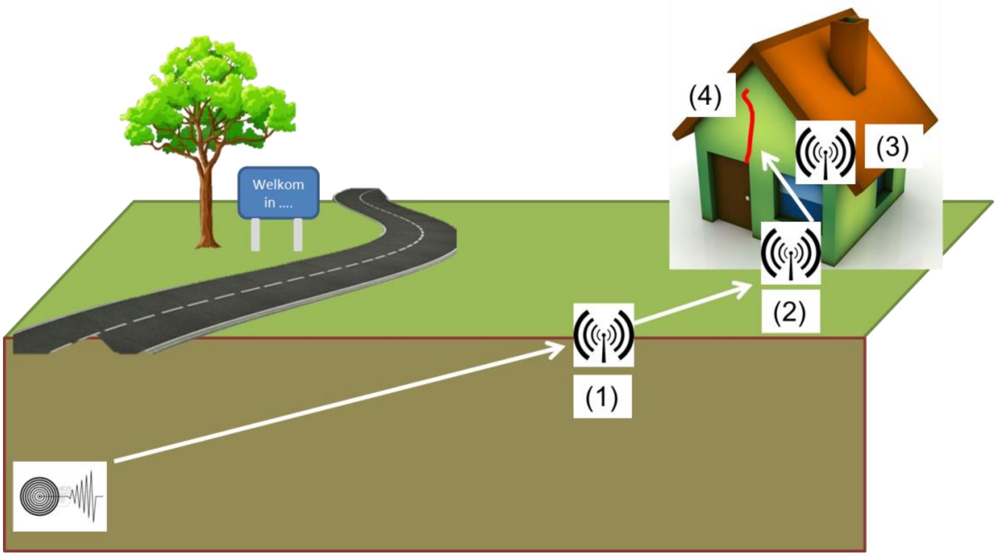

Figure 2.1: Illustration of the vibration path of an earthquake

<u>Ad 1: Ground-borne vibrations</u>
The ground-borne vibrations of step 1 are measured and analysed by KNMI via their own (separate) monitoring network, hence this effect is not part of the analysis procedure of this monitoring network.

<u>Ad 2: Vibration load on buildings</u>
Ground-borne vibrations are (probably) not transferred to the buildings one-to-one. The extent to which the ground-borne vibrations are transferred to buildings is characterised in practice by a transfer function. The transfer of vibrations depends on several factors, such as local soil conditions, type of foundation, etc.
To obtain insight into the building vibrations, vibration measurements are performed in about 350 buildings, at foundation level. The buildings included in the monitoring network are selected in such a way that they are representative for the majority of the buildings in Groningen.

<u>Ad 3: Damage caused by vibrations</u>
In the Netherlands, there are no rules or regulations for the determination of damage caused by vibrations. SBR Guideline A [02] is available which included

methods to assess and evaluate vibration levels, to prevent damage due to vibrations. Criteria are determined for different construction types and states.
Recent research into the relation between vibration levels and damage to structures provided additional insight in the form of ‘damage curves’, which serve as a background for the 2017 revision of SBR Guideline A [02]. Although these damage curves can be used to estimate the probability of damage for a particular vibration velocity, they provide no information on the severity of the damage.
As SBR Guideline A is primarily written to prevent damage by vibrations, the focus is on crack initiation, rather than on the occurrence of higher damage states.
After each earthquake above the magnitude M=2.5, a damage survey is carried out in the buildings that have a vibration level above a pre-set threshold (v=1 mm/s). The severity of the damage is classified in damage categories. By plotting the damage categories of the respective buildings against the vibration characteristics, new damage curves can be established in which the severity of the damage is related to the vibration characteristics on foundation level.

3 Buildings triggered by earthquakes

The buildings for which the measured foundation vibration velocity (v_{max}) has exceeded 1 mm/s are analysed (see TNO-report “Monitoring Network Building Vibrations” [01]). This trigger level of 1 mm/s is commonly regarded as the lowest limit for damage due to vibrations.

Within the monitoring network every building has an unique identification number (ID). For privacy reasons these ID numbers are not used in this report. The ID-numbers of the buildings triggered at the Zeerijp earthquake are replaced by the letter Z (Zeerijp), followed by a new number (this is a specific number, only used in this report).

During the Zeerijp earthquake, the building vibration velocity at foundation level (v_{max}) exceeded 1 mm/s in a total of 209 buildings:

- 197 triggered buildings are houses; these houses are selected for both signal analysis and damage analysis. However, for 4 of these houses no damage analysis is executed: 2 because an initial damage survey was not yet executed at the time of the earthquake (Z4 and Z6), 1 due to relocation of the owners (Z46) and 1 because there is no masonry in the facades (Z157).
- 5 triggered buildings are a town hall (Objects Z180, Z181, Z182, Z183 and Z188); these town halls are selected for signal analysis, but excluded from damage analysis.
- 1 triggered building is a stadium (Z179); this stadium is selected for signal analysis, but excluded from damage analysis.
- 1 triggered building is a chimney (Z186); this chimney is selected for signal analysis, but excluded from damage analysis.
- 4 triggered buildings are a NAM building (Z184, Z189, Z191 and Z192); these buildings are selected for signal analysis, but excluded from damage analysis.
- 1 triggered building is a school (Z190); this school is selected for signal analysis, but excluded from damage analysis.

During the Zeerijp earthquake, no vibration data was recorded in 4 buildings which were located at a distance of the epicenter where a trigger was expected (Z207, Z208, Z209 and Z210). The reason for the absence of vibration data was a temporary malfunctioning of the sensor in these 4 buildings. Since for these buildings a vibration level exceeding 1 mm/s is expected, these objects were selected for damage analysis.

An overview of triggered buildings is given in table 3.1. This table provides the following information:

- Z-code of the analyzed building.
- Building typology (see Annex A; Table A.1)
- Year of construction
- Foundation type
- Damage state (DS) at the most recent damage survey before the earthquake
- Maximum measured, horizontal component of the building vibration velocity at foundation level ($v_{x,y,max}$) during the earthquake (for definition $v_{x,y,max}$ see Paragraph 4.2).

- The data of the previous damage survey and the repetitive damage survey for Zeerijp.

Figure 3.1 shows a map with the maximum measured, horizontal component of the building vibration velocities at the foundation level ($v_{x,y,max}$) of all triggered buildings with respect to the epicentre of the earthquake, as given by KNMI (see Chapter 1.2).

Figure 3.2 shows a graph with the maximum vibration velocities at the foundation level (v_{max}) of all buildings (also the non-triggered buildings) with respect to the epicentre of the earthquake, as given by KNMI. Figure 3.3 shows the same graph for the vibration acceleration.

Table 3.1: Buildings triggered by Zeerijp earthquake

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z1	3	2007	piles	1	1,9	13-11-2014	26-3-2018
Z2	7	1967	no piles	2	2,3	8-12-2014	13-3-2018
Z3	4	1904	no piles	1	12,9	26-1-2015	13-2-2018
Z4 [a]	5	1875	no piles	--	1,0	--	--
Z5	5	1901	no piles	1	2,1	1-8-2014	6-2-2018
Z6 [a]	6	1851	unknown	--	1,1	--	--
Z7	6	1920	unknown	0	1,9	22-8-2014	27-2-2018
Z8	4	1920	no piles	1	4,7	11-2-2015	29-1-2018
Z9	4	1880	no piles	2	2,2	29-8-2014	13-3-2018
Z10	9	1980	no piles	1	3,3	9-12-2014	27-2-2018
Z11	5	1927	no piles	2	2,0	22-8-2014	27-3-2018
Z12	4	1890	no piles	1	16,3	11-2-2015	23-1-2018
Z13	6	1800	unknown	1	14,4	28-1-2015	12-2-2018
Z14	7	1970	piles	1	2,7	3-2-2015	21-3-2018
Z15	3	1992	piles	1	2,4	28-1-2015	22-3-2018
Z16	4	1905	no piles	1	2,2	21-10-2015	25-1-2018
Z17	4	1928	no piles	1	12,6	7-11-2014	12-2-2018
Z18	3	1994	piles	1	10,7	26-1-2015	23-1-2018
Z19	4	1936	no piles	1	2,0	14-11-2014	13-3-2018
Z20	2	2007	piles	0	1,6	24-4-2015	12-3-2018
Z21	4	1920	unknown	1	1,4	9-10-2014	8-2-2018
Z22	4	1905	no piles	2	18,0	11-2-2015	23-1-2018
Z23	4	1920	unknown	2	2,3	4-11-2014	7-3-2018
Z24	5	1905	no piles	1	2,5	1-5-2015	22-3-2018
Z25	7	1954	unknown	1	5,0	5-8-2014	1-3-2018
Z26	8	1980	piles	1	1,0	30-7-2014	6-3-2018
Z27	9	1998	no piles	1	1,2	19-10-2015	22-1-2018

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z28	9	1995	no piles	1	2,5	29-6-2015	8-3-2018
Z29	3	1979	piles	1	3,0	24-4-2015	14-3-2018
Z30	1	1910	piles	2	1,0	6-5-2015	9-2-2018
Z31	7	1959	no piles	1	11,3	28-1-2015	14-2-2018
Z32	6	1930	no piles	1	2,0	10-2-2015	27-2-2018
Z33	6	1930	no piles	2	3,1	21-8-2014	27-3-2018
Z34	1	1968	piles	1	1,4	22-4-2015	19-3-2018
Z35	8	1995	piles	0	5,1	26-2-2015	1-2-2018
Z36	8	1998	unknown	1	1,7	5-11-2014	1-3-2018
Z37	6	1932	no piles	1	1,8	13-11-2014	22-1-2018
Z38	8	1991	piles	1	11,6	27-1-2015	15-2-2018
Z39	7	1952	unknown	1	13,5	28-1-2015	15-2-2018
Z40	5	1933	no piles	1	27,2	29-1-2015	1-2-2018
Z41	3	2008	piles	1	2,7	18-11-2014	22-2-2018
Z42	7	1967	no piles	2	1,1	29-7-2014	5-2-2018
Z43	8	2002	piles	1	13,5	27-1-2015	14-2-2018
Z44	5	1934	unknown	1	8,5	29-1-2015	21-2-2018
Z45	4	1935	no piles	1	1,7	13-11-2014	12-3-2018
Z46 [b]	4	1920	no piles	--	2,3	19-2-2015	--
Z47	6	1926	no piles	0	5,2	9-12-2014	19-2-2018
Z48	4	1925	no piles	2	2,0	13-11-2014	14-3-2018
Z49	8	1991	piles	1	9,3	27-1-2015	15-2-2018
Z50	9	1976	no piles	1	2,8	18-2-2015	8-3-2018
Z51	4	1870	no piles	2	2,0	10-11-2014	12-3-2018
Z52	8	2000	piles	1	2,5	8-12-2014	28-3-2018
Z53	4	1800	no piles	1	2,6	6-11-2014	15-3-2018
Z54	1	1938	no piles	0	1,1	10-9-2014	28-3-2018
Z55	4	1860	unknown	2	1,9	6-11-2014	8-2-2018
Z56	7	1955	unknown	2	25,3	9-2-2015	6-2-2018
Z57	8	1975	unknown	1	1,1	20-10-2015	20-3-2018
Z58	2	1925	no piles	1	1,6	12-9-2014	30-1-2018
Z59	8	2002	piles	1	1,6	26-6-2015	5-2-2018
Z60	8	1989	piles	1	9,9	27-1-2015	15-2-2018
Z61	3	1990	piles	1	3,2	28-1-2015	31-1-2018
Z62	4	1920	no piles	1	8,4	9-2-2015	6-2-2018
Z63	1	1970	piles	0	1,1	10-10-2014	1-3-2018
Z64	6	1800	no piles	2	1,5	15-7-2014	6-2-2018
Z65	3	1961	unknown	1	2,3	15-6-2016	31-1-2018
Z66	3	1985	piles	1	3,0	28-1-2015	2-3-2018
Z67	1	1980	unknown	1	1,8	4-9-2014	6-3-2018

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z68	9	2003	piles	1	1,1	4-6-2015	28-3-2018
Z69	3	1982	piles	1	2,0	13-11-2014	19-1-2018
Z70	8	2007	piles	1	3,9	18-11-2014	11-3-2018
Z71	9	1991	no piles	1	2,8	23-6-2015	7-3-2018
Z72	2	1912	unknown	2	1,8	28-4-2015	22-3-2018
Z73	8	1999	piles	1	1,6	26-2-2015	6-2-2018
Z74	5	1830	no piles	2	10,9	16-6-2015	12-2-2018
Z75	2	1983	piles	1	2,4	12-11-2014	22-1-2018
Z76	4	1925	no piles	1	27,6	29-1-2015	1-3-2018
Z77	2	1983	piles	1	2,1	3-2-2015	19-3-2018
Z78	7	1964	no piles	1	4,5	6-11-2014	22-2-2018
Z79	4	1925	no piles	1	1,8	10-11-2014	1-3-2018
Z80	8	2000	piles	1	1,6	26-2-2015	8-2-2018
Z81	6	1910	no piles	1	10,4	28-1-2015	15-2-2018
Z82	4	1862	no piles	1	1,8	21-4-2015	31-1-2018
Z83	1	1994	unknown	1	2,8	12-11-2014	21-3-2018
Z84	8	1997	piles	1	5,4	6-11-2014	19-2-2018
Z85	7	1970	no piles	1	4,8	26-2-2015	19-2-2018
Z86	8	2002	piles	1	1,0	2-9-2014	24-1-2018
Z87	3	1947	no piles	2	1,9	12-11-2014	31-1-2018
Z88	4	1900	unknown	1	2,2	7-5-2015	5-3-2018
Z89	4	1952	no piles	1	3,4	2-9-2014	21-2-2018
Z90	5	1934	no piles	1	1,7	18-9-2014	30-1-2018
Z91	8	1993	piles	1	12,1	29-1-2015	15-2-2018
Z92	6	1896	no piles	1	1,6	19-2-2015	22-3-2018
Z93	7	1972	no piles	1	22,0	29-1-2015	1-2-2018
Z94	3	1999	piles	1	1,5	28-1-2015	22-1-2018
Z95	8	1988	piles	1	2,6	29-1-2015	12-3-2018
Z96	6	1900	no piles	2	1,0	15-8-2014	13-3-2018
Z97	6	1912	no piles	1	2,6	4-8-2014	27-2-2018
Z98	3	2000	piles	1	1,1	17-6-2015	15-3-2018
Z99	7	1969	no piles	1	2,1	10-2-2015	27-3-2018
Z100	4	1910	no piles	1	3,6	9-12-2014	15-3-2018
Z101	6	1890	no piles	1	2,0	18-2-2015	6-3-2018
Z102	1	1965	no piles	1	2,6	11-11-2014	6-3-2018
Z103	3	1996	piles	1	1,9	18-11-2014	12-3-2018
Z104	6	1915	no piles	1	2,0	16-7-2014	1-3-2018
Z105	7	1962	no piles	1	3,5	6-7-2015	24-2-2018
Z106	4	1910	no piles	1	2,3	30-4-2015	27-3-2018
Z107	6	1927	no piles	1	2,4	18-11-2014	8-2-2018

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z108	5	1929	no piles	2	1,7	5-2-2015	5-2-2018
Z109	5	1910	no piles	1	2,7	18-2-2015	8-3-2018
Z110	3	1982	unknown	1	3,3	17-6-2015	27-3-2018
Z111	5	1932	no piles	1	23,8	9-12-2014	25-1-2018
Z112	5	1905	unknown	1	4,7	6-5-2015	5-3-2018
Z113	6	1926	no piles	2	2,3	5-8-2014	24-2-2018
Z114	6	1926	no piles	1	12,8	19-2-2015	13-2-2018
Z115	8	1995	piles	1	4,8	5-2-2015	1-3-2018
Z116	8	2010	piles	1	16,1	21-10-2015	12-2-2018
Z117	9	1997	no piles	0	4,0	19-8-2014	15-3-2018
Z118	9	2001	no piles	0	2,9	18-8-2014	7-3-2018
Z119	5	1870	unknown	2	13,7	27-1-2015	13-2-2018
Z120	7	1956	no piles	1	3,3	5-2-2015	27-2-2018
Z121	8	1999	piles	1	10,8	19-2-2015	13-2-2018
Z122	9	1979	no piles	1	4,1	10-2-2015	27-2-2018
Z123	8	1992	piles	1	10,3	29-1-2015	21-2-2018
Z124	5	1936	no piles	1	2,5	8-12-2014	22-3-2018
Z125	6	1925	no piles	1	11,3	27-1-2015	14-2-2018
Z126	5	1938	no piles	2	2,3	19-2-2015	19-1-2018
Z127	3	1988	piles	1	4,5	26-2-2015	19-2-2018
Z128	8	1996	piles	1	12,8	23-6-2015	12-2-2018
Z129	4	1889	no piles	2	9,1	29-1-2015	24-2-2018
Z130	3	1993	piles	1	3,0	7-11-2014	6-3-2018
Z131	8	1992	piles	1	1,1	28-1-2015	15-3-2018
Z132	1	1974	unknown	1	1,6	18-11-2014	26-1-2018
Z133	3	1986	no piles	1	2,4	12-11-2014	26-1-2018
Z134	3	1996	piles	1	1,8	12-11-2014	26-1-2018
Z135	9	1986	no piles	0	2,5	10-2-2015	27-2-2018
Z136	5	1934	no piles	1	1,8	11-11-2014	6-3-2018
Z137	5	1925	no piles	2	6,9	26-1-2015	21-2-2018
Z138	5	1938	no piles	1	4,0	7-11-2014	6-2-2018
Z139	5	1930	no piles	2	2,5	10-11-2014	2-3-2018
Z140	9	1978	no piles	1	3,1	29-4-2015	2-3-2018
Z141	3	1979	piles	2	1,6	11-11-2014	19-1-2018
Z142	4	1800	no piles	1	9,2	19-2-2015	19-2-2018
Z143	4	1900	no piles	1	1,6	4-8-2014	29-1-2018
Z144	8	2012	piles	0	3,3	10-2-2015	27-2-2018
Z145	5	1906	unknown	2	2,1	7-8-2014	1-3-2018
Z146	5	1938	no piles	1	1,7	19-9-2014	1-3-2018
Z147	3	1974	no piles	1	4,4	1-7-2015	6-2-2018

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z148	8	1988	piles	1	2,1	20-4-2015	30-1-2018
Z149	9	1979	no piles	1	6,7	9-2-2015	29-1-2018
Z150	6	1842	no piles	1	6,4	9-2-2015	6-3-2018
Z151	7	1955	no piles	1	25,0	4-9-2014	1-2-2018
Z152	7	1968	no piles	1	1,6	13-11-2014	12-3-2018
Z153	4	1903	no piles	2	9,6	27-1-2015	13-2-2018
Z154	4	1830	no piles	1	2,7	3-2-2015	25-1-2018
Z155	3	1994	piles	1	2,4	14-11-2014	6-3-2018
Z156	7	1950	unknown	1	1,8	7-11-2014	21-3-2018
Z157 [c]	nvt	1950	no piles	--	1,0	--	--
Z158	3	1989	piles	1	2,4	18-11-2014	20-3-2018
Z159	3	1987	piles	1	1,1	18-7-2014	24-1-2018
Z160	9	2008	no piles	1	5,8	19-2-2015	19-2-2018
Z161	9	1996	no piles	1	1,3	22-10-2015	9-2-2018
Z162	6	1900	no piles	0	2,9	19-8-2014	7-3-2018
Z163	3	1992	piles	1	2,5	10-11-2014	19-3-2018
Z164	3	1996	piles	1	5,7	6-11-2014	1-2-2018
Z165	4	1900	no piles	0	3,6	25-1-2016	8-2-2018
Z166	4	1912	no piles	1	2,2	3-2-2015	10-4-2018
Z167	4	1933	no piles	1	1,6	30-6-2015	26-3-2018
Z168	1	1971	piles	1	1,1	22-10-2015	15-3-2018
Z169	2	1971	unknown	1	1,1	22-10-2015	15-3-2018
Z170	7	1960	unknown	2	1,0	18-5-2015	8-3-2018
Z171	9	1993	no piles	2	2,5	9-6-2015	20-3-2018
Z172	6	1938	no piles	1	2,2	19-5-2015	15-3-2018
Z173	5	1900	unknown	2	1,5	20-5-2015	12-3-2018
Z174	4	1927	no piles	2	5,2	2-11-2015	1-3-2018
Z175	2	1928	no piles	1	1,1	26-5-2015	14-3-2018
Z176	2	2010	piles	1	1,7	8-6-2015	9-2-2018
Z177	5	1924	no piles	0	2,7	8-6-2015	8-3-2018
Z178	3	2007	piles	1	2,8	9-6-2015	5-3-2018
Z179 [d]	10	unknown	unknown	--	1,9	--	--
Z180 [e]	10	1968	piles	--	13,9	--	--
Z181 [e]	10	unknown	no piles	--	1,6	--	--
Z182 [e]	10	unknown	no piles	--	2,2	--	--
Z183 [e]	10	unknown	unknown	--	3,4	--	--
Z184 [f]	10	unknown	piles	--	2,4	--	--
Z185.1	10	1925	no piles	3	3,2	30-10-2014	19-1-2018
Z185.2	10	1925	no piles	3	3,2	30-10-2014	19-1-2018
Z186 [g]	10	unknown	unknown	--	2,1	--	--

Code	Type	Year of construction	Foundation type	Damage state (DS; before earthquake)	$v_{x,y,max}$ (mm/s)	Damage survey	
						Previous survey	Survey Zeerijp
Z187	2	1983	unknown	1	2,2	12-11-2014	7-5-2018
Z188 [e]	10	1925	unknown	--	1,2	--	--
Z189 [f]	10	unknown	unknown	--	1,2	--	--
Z190 [h]	10	2006	unknown	--	1,0	--	--
Z191 [f]	10	--	--	--	4,0	--	--
Z192 [f]	10	--	--	--	1,0	--	--
Z193	9	1994	no piles	1	1,1	19-6-2015	22-3-2018
Z194	3	1994	unknown	1	1,2	29-6-2015	22-3-2018
Z195.1	3	2015	no piles	0	2,1	28-7-2015	6-3-2018
Z195.2	3	2015	no piles	0	1,9	28-7-2015	6-3-2018
Z196	5	1841	no piles	2	1,1	9-10-2015	20-3-2018
Z197	4	1860	no piles	2	1,3	29-9-2015	26-3-2018
Z198	8	2015	piles	0	1,3	13-10-2015	26-3-2018
Z199	--	--	--	1	3,1	1-3-2017	22-2-2018
Z200	--	--	--	2	2,2	27-2-2017	31-1-2018
Z201	4	1900	no piles	3	4,1	24-6-2016	20-3-2018
Z202	3	1987	piles	1	4,2	10-5-2016	12-2-2018
Z203	4	1800	no piles	2	3,+5	15-6-2016	13-3-2018
Z204	8	1990	piles	1	1,4	12-5-2016	28-3-2018
Z205	--	--	--	1	2,0	27-2-2017	8-2-2018
Z206	--	--	--	1	1,7	13-7-2017	19-3-2018
Z207 [k]	4	1989	no piles	1	2,0	5-9-2014	13-3-2018
Z208 [k]	8	1918	no piles	2	3,0	20-2-2015	21-3-2018
Z209 [k]	4	1975	no piles	1	3,0	18-2-2015	8-3-2018
Z210 [k]	3	2001	piles	1	1,0	30-1-2015	7-5-2018
Z211	4	1930	no piles	2	1,2	28-6-2017	22-1-2018
Z212	6	1912	no piles	1	13,2	26-1-2015	14-5-2018
Z213	3	2002	piles	0	2,5	28-9-2015	29-5-2018

a - An initial damage survey was not yet executed at the time of the earthquake
b - No damage survey is executed due to relocation of owners
c - No damage survey because there is no masonry in the facades
d - Stadium, no damage survey is needed
e - Townhall, no damage survey is needed
f - NAM building, no damage survey is needed
g - Chimney, no damage survey is needed
h - School, no damage survey is needed
k - No vibration data due to temporary malfunctioning of the sensor; v_{max} estimated, based on distance to epicentre

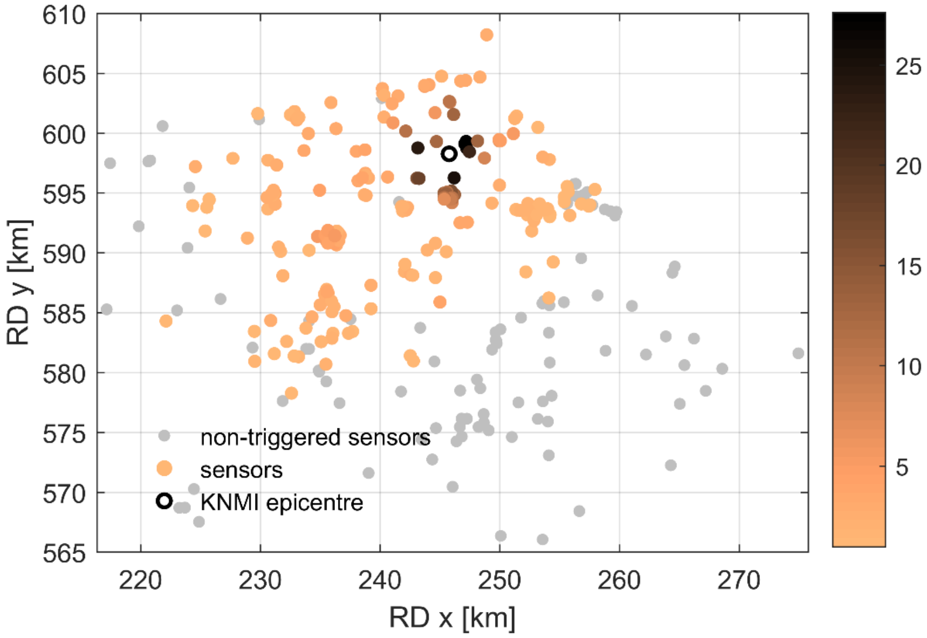

Figure 3.1: Map with the maximum measured, horizontal component of the building vibration velocity at foundation level ($v_{x,y,max}$ mm/s) with respect to the epicentre of the Zeerijp earthquake

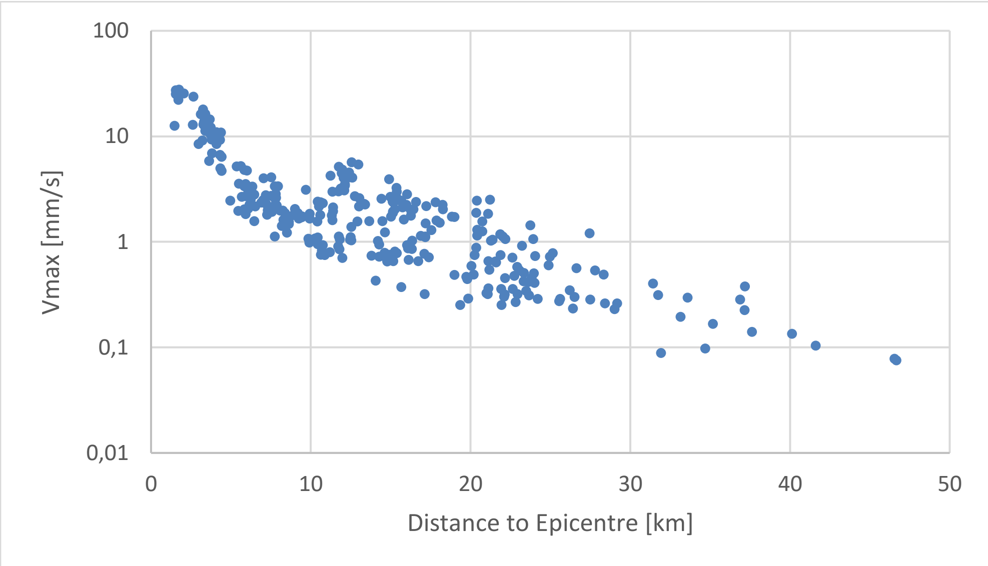

Figure 3.2: Graph with the maximum measured building vibration velocity at foundation level (v_{max} mm/s) with respect to the epicentre of the Zeerijp earthquake

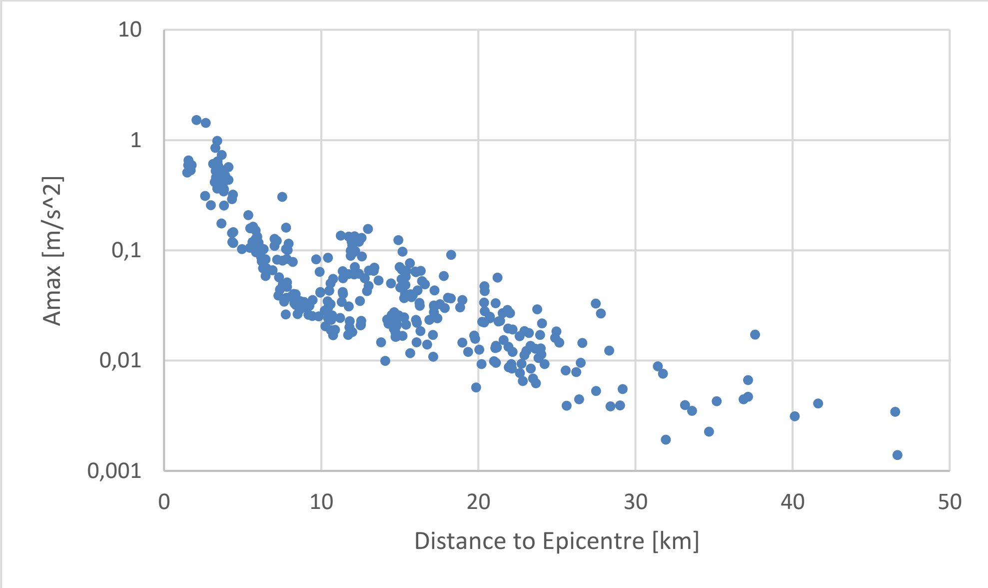

Figure 3.3: Graph with the maximum measured building vibration acceleration at foundation level (a_{max} m/s^2) with respect to the epicentre of the Zeerijp earthquake

4 Framework analysis building vibrations

4.1 General

The building sensors measure building vibration accelerations at the foundation level. Out of these measured accelerations the sensor systems calculate automatically the vibration velocity and these calculated vibration velocities are used to determine if the pre-set trigger, a vibration velocity of 1 mm/s, is exceeded. After the pre-set trigger is exceeded, the sensor system sends the originally measured vibration accelerations to the vibration data center (VDC). These originally measured accelerations are used for the analysis of the building vibrations.

4.2 Vibration characteristics

For each building the measured acceleration signal by the building sensor is analysed as follows (Figure 4.1):

- Two time-domain signals are calculated:
  - The raw measured acceleration signal a(t) is used after removal of the offset.
  - After filtering the signal is integrated to a velocity signal v(t).
- The frequency spectrum is calculated for the acceleration and the velocity signals.
- Individual signal characteristics are calculated for each of the three signal directions per sensor (two in the horizontal direction (x and y) and one in vertical direction (z)):
  - Acceleration [a]; this value is used in international earthquake guidelines and is of interest for structural calculations. Calculated values are: $a_{x,\,max}$, $a_{y,\,max,}$ $a_{z,\,max}$ and $a_{x,y,max}$ (=peak acceleration in horizontal direction).
  - Velocity [*v*]; this value is used in the Dutch guidelines (SBR ref [02]) for relations between building vibrations and the probability of damage. Calculated values are: $v_{x,\,max}$, $v_{y,\,max,}$ $v_{z,\,max.}$ and $v_{x,y,max}$ (=peak velocity in the horizontal direction).
  - Effective velocity [$v_{eff,max}$]; this value is mostly used to express a relation between the vibration and the hindrance for people (ref [03]).
  - Dominant frequency of acceleration [$f_{a,dom}$] and velocity [$f_{v,dom}$]; these values are of interest for the transfer of the ground-borne vibrations to the building vibrations.
  - The vectorial maximum of the acceleration ($|a(t)|_{max}$) and the velocity ($|v(t)|_{max}$) are calculated ($|a(t)| = \sqrt{(a_x(t))^2 + (a_y(t))^2 + (a_z(t))^2}$). These are absolute values of the acceleration and the velocity, independent from the orientation of the sensor.
- The Arias Intensity. For the x-channel this is given by $I_{A,x} = \frac{\pi}{2g}\int_0^T a_x(t)^2 dt$ with T the length of the time trace. The y- and z-channels are calculated in a similar way.
- The Total Arias Intensity. This is given by $I_{A,total} = I_{A,x} + I_{A,y} + I_{A,y}$.
- The Cumulative Absolute Velocity (CAV). For the x-channel this is given by: $CAV_x = \int_0^T |a_x(t)| dt$ and similar for the y- and z- channels.
- The Total Cumulative Absolute Velocity. This is given by $CAV_{total} = CAV_x + CAV_y + CAV_z$.

- The Standardized Cumulative Absolute Velocity CAV_{STD}. This is calculated in a similar fashion as the CAV but here the signal is divided into 1 second long sections and a section is only taken into account if there is a moment in the section where the absolute acceleration is above a certain threshold. Currently this threshold is set to 0.001g. This prevents the CAV_{STD} from keeping accumulating after the event contrary to the CAV can do.

The calculation of the Arias Intensity, CAV and CAV_{STD} is performed on the raw acceleration signal after offset removal. No filtering is applied. Tests show that results differ less than 1% for the current events. Larger events are likely to have a lower frequency content which is perhaps partly affected by the filter, so it has been chosen to perform the calculations on the unfiltered signal.

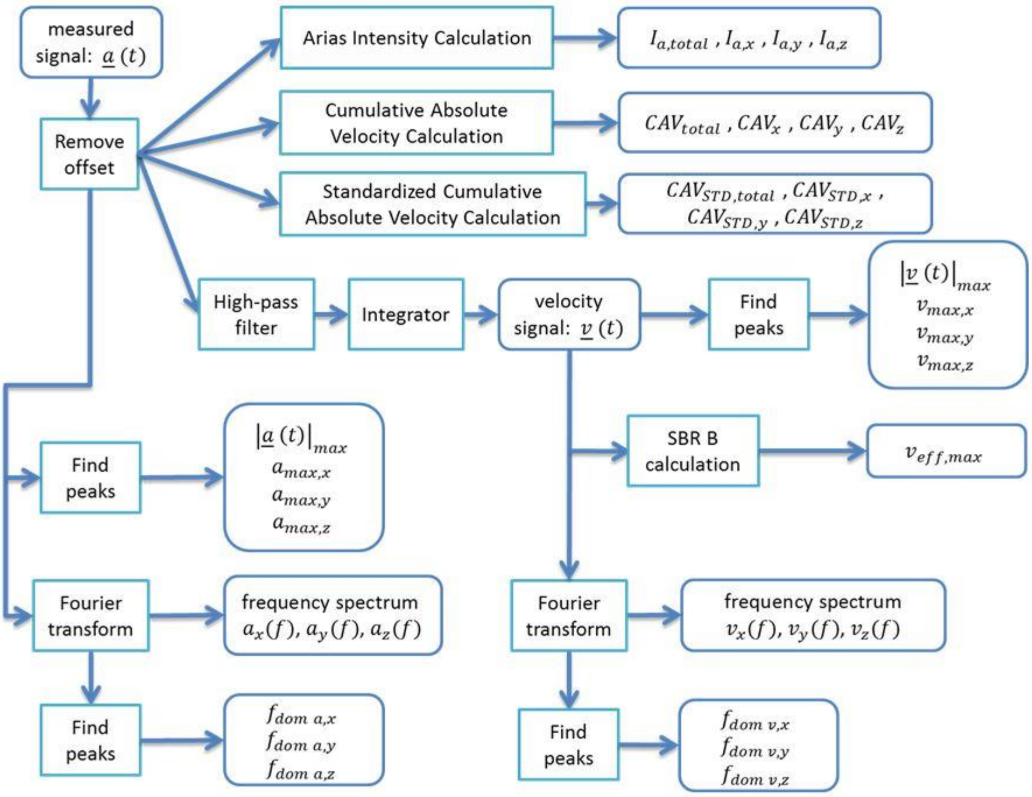

Figure 4.1: Flow chart for analysing signal characteristics

4.3 Transfer functions

There are three main sources of information along the chain from the epicenter of an earthquake to the exposed buildings, namely:

(i) the magnitude and location of the earthquake
(ii) the free-field signal characteristics at the KNMI instrument points
(iii) the foundation signal characteristics in the buildings.

The first two sources are covered by KNMI. KNMI has installed free-field sensors in a grid of 6 km within the area of the monitoring network, to measure the free field characteristics.

The relationship between the vibration signal characteristics at the KNMI free-field points (ii) and the ones measured on the building foundations (iii) can be used to calculate the transfer function of the ground-borne vibrations to the building vibrations at foundation level. However, for calculating a reliable transfer factor, the distance between the two sensor must be rather small. At the Zeerijp earthquake the shortest distance between a KNMI- station and a triggered building is 130 m (KNMI station G160; TNO Z41). This distance is too big to calculate a reliable transfer factor for the field acceleration to the individually measured foundation accelerations.

5 Vibration characteristics

The vibration signals of the triggered buildings are recorded for a period of 30 s, about 10 s before and 20 s after the beginning of the signal from the earthquake. An example of such a vibration signal is given in Figure 5.1. Annex B of this report gives examples of the measured vibration acceleration signals of four buildings for the Zeerijp earthquake. The same Annex also gives graphs with the distribution of the frequency of each signal.
Annex C gives the same information regarding the calculated vibration velocity signals and the distribution of the frequency of each signal.

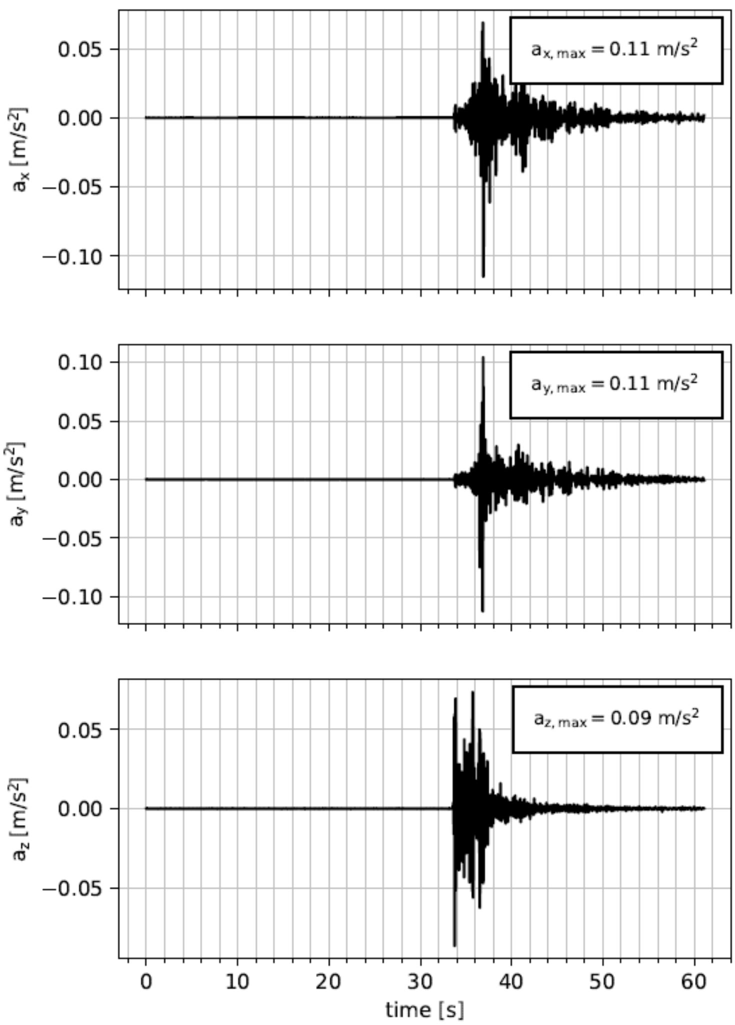

Figure 5.1: Example of a measured vibration acceleration signal from the Zeerijp event (Object Z144).

The calculated vibration characteristics regarding the acceleration are given in Annex D:

- Peak acceleration in three directions: $a_{x,max}$,$a_{y,max}$,$a_{z,max}$

- Peak acceleration in horizontal direction: $a_{x,y,max}$ = maximum ($a_{x,max}$ and $a_{y,max}$)
- Vectorial maximum of the acceleration: maximum of |a(t)|
- Dominant frequency of acceleration in three directions: $f_{a,dom,x}$,$f_{a,dom,y}$,$f_{a,dom,z}$

The peak vibration acceleration of all buildings triggered by the Zeerijp earthquake is presented in Figure 5.2. A distinction is made between the horizontal (x,y) and the vertical (z) component of the vibration acceleration.
The maximum measured peak acceleration in the horizontal direction is 1.52 m/s^2 and in the vertical direction 1.05 m/s^2.

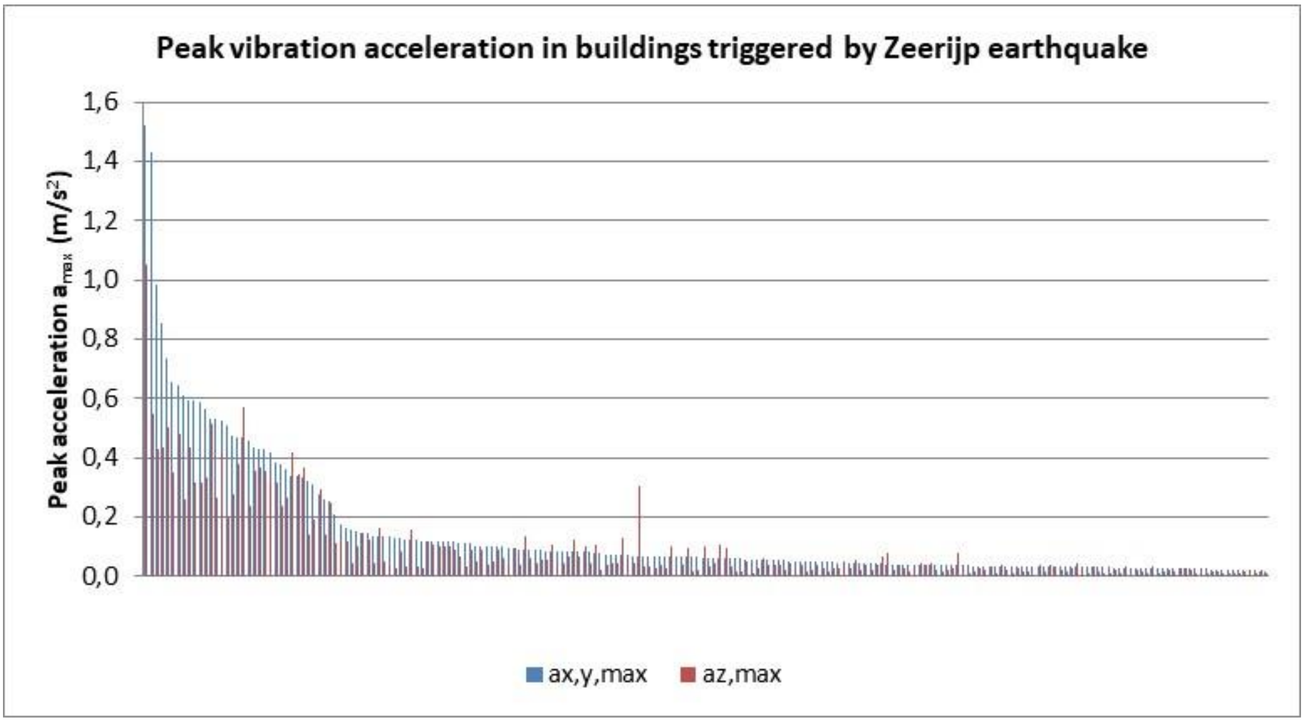

Figure 5.2: Peak acceleration of all buildings triggered by the Zeerijp earthquake

The calculated vibration characteristics regarding the velocity are given in Annex E:

- Peak velocity in three directions: $v_{x,max}$,$v_{y,max}$,$v_{z,max}$
- Peak velocity in horizontal direction: $v_{x,y,max}$ = maximum ($v_{x,max}$ and $v_{y,max}$)
- Vectorial maximum of the velocity: maximum of |v(t)|
- Dominant frequency of velocity in three directions: $f_{v,dom,x}$,$f_{v,dom,y}$,$f_{v,dom,z}$
- Peak effective velocity in three directions: $v_{eff,x,max}$,$v_{eff,y,max}$,$v_{eff,z,max}$
- Peak effective velocity: $v_{eff,max}$ = maximum of ($v_{eff,x,max}$,$v_{eff,y,max}$,$v_{eff,z,max}$)

The peak vibration velocity of all buildings triggered by the Zeerijp earthquake is presented in Figure 5.3. A distinction is made between the horizontal (x,y) and the vertical (z) component of the vibration velocity.
The maximum measured peak vibration velocity in the horizontal direction is 27.6 mm/s and in the vertical direction 7.0 mm/s.

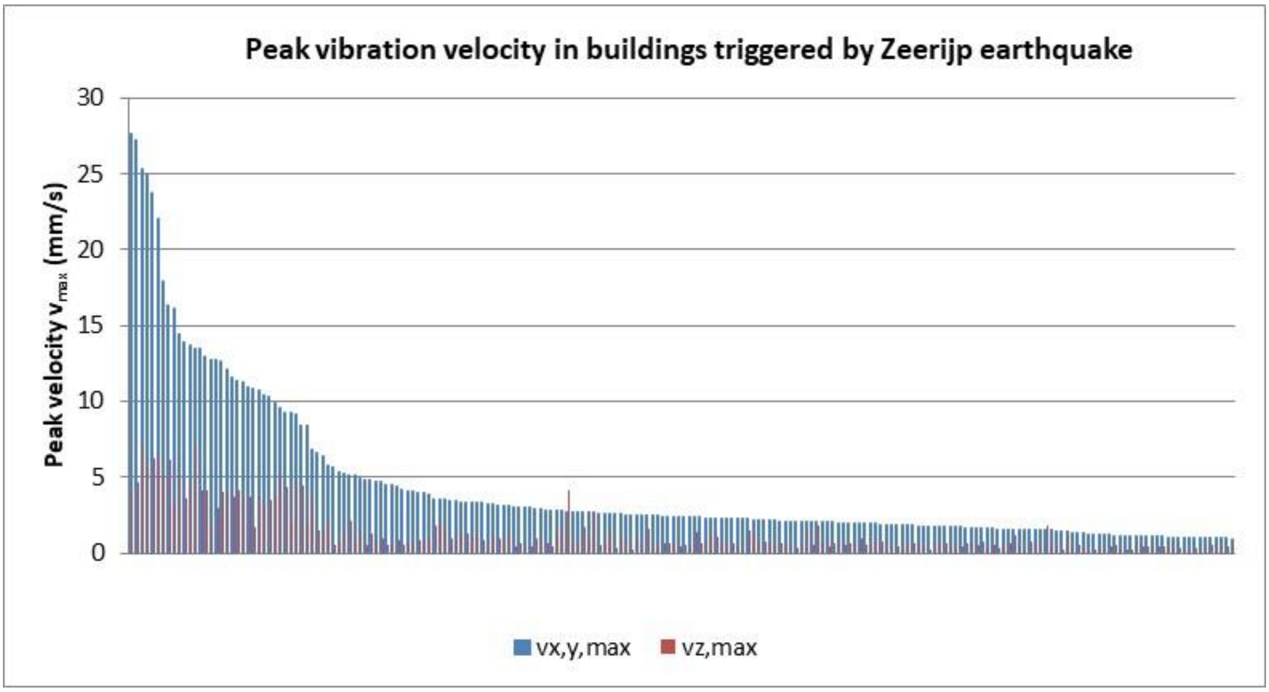

Figure 5.3: Peak velocity of all buildings triggered by the Zeerijp earthquake

The calculated vibration characteristics regarding the Cumulative Absolute Velocity are given in Annex F:

- Cumulative Absolute Velocity in three directions: CAV_x, CAV_y, CAV_z
- Total Cumulative Absolute Velocity: CAV_{total}
- Standardized Cumulative Absolute Velocity in three directions: $CAV_{STD,x}$, $CAV_{STD,y}$, $CAV_{STD,z}$
- Total Standardized Cumulative Absolute Velocity: $CAV_{STD,total}$

The calculated vibration characteristics regarding the Arias Intensity are given in Annex G:

- Arias Intensity in three directions: $I_{A,x}$, $A_{A,y}$, $A_{A,z}$
- Total Cumulative Arias Intensity: $I_{A,total}$

The horizontal and the vertical component of the vibration of each building are compared, to see which direction gives the highest vibrations. This is done for both the peak acceleration (Figure 5.4) and the peak velocity (Figure 5.5). For the Zeerijp earthquake the horizontal velocity is mostly dominant over the vertical velocity component. In case of the accelerations this is a little less obvious, but in most cases the horizontal acceleration component is also dominant over the vertical one.

Figure 5.6 shows the vertical to horizontal ratio for the accelerations versus the distance to the epicentre. The graph shows no clear relation between this ratio and the distance to the epicentre.

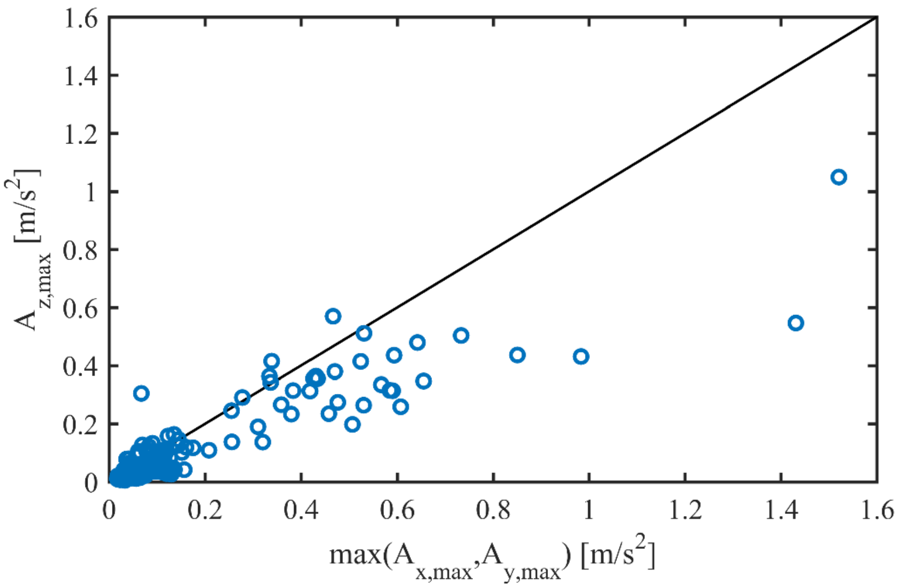

Figure 5.4: Horizontal versus vertical component of peak acceleration for all buildings triggered by the Zeerijp earthquake

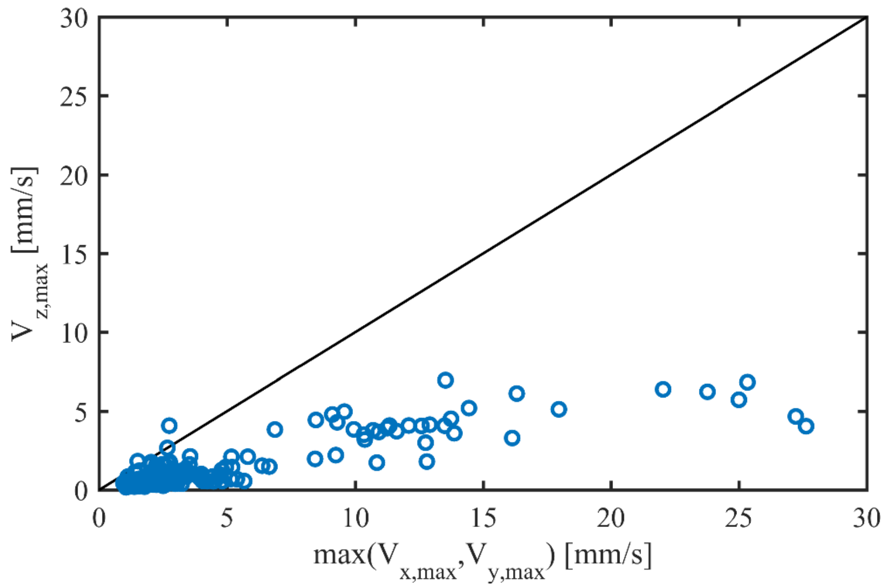

Figure 5.5: Horizontal versus vertical component of peak velocity for all buildings triggered by the Zeerijp earthquake

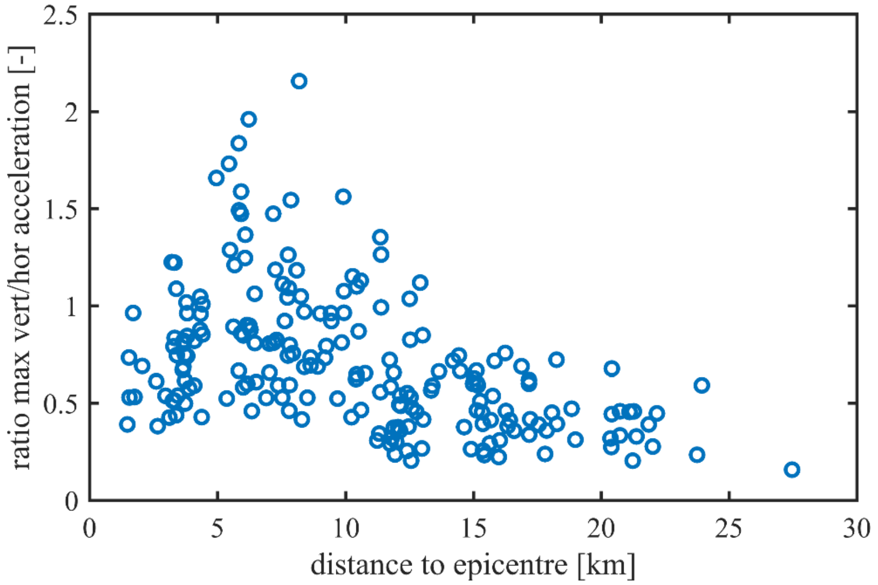

Figure 5.6: Ratio of vertical to horizontal peak acceleration versus the distance to the epicenter for all buildings triggered by the Zeerijp earthquake

The peak acceleration and the peak velocity are compared to each other to look for the relation between these two characteristics. The results of this comparison are given in Figure 5.7. For the lower levels of vibration Figure 5.7 shows a rather linear relation between the peak acceleration and the peak velocity for most of the buildings. For the higher levels there is no relation between these two vibration characteristics.

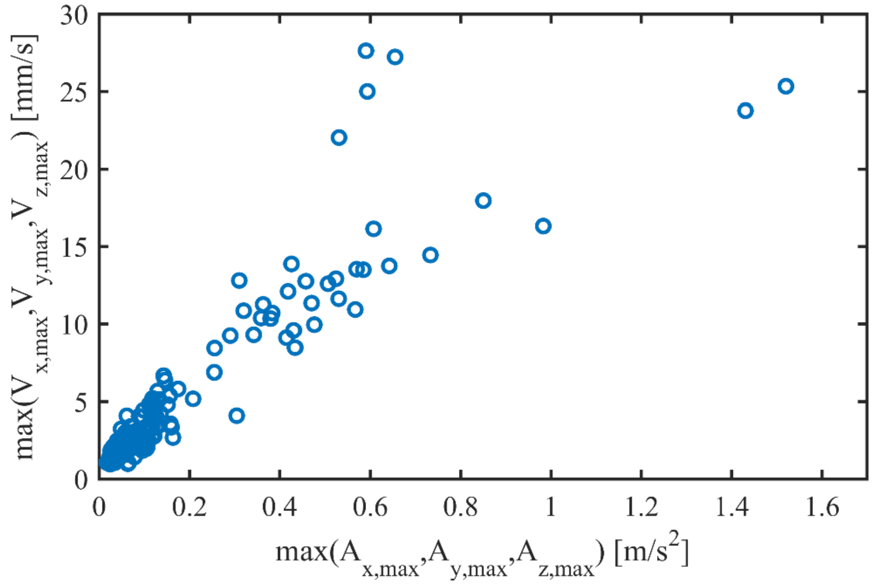

Figure 5.7: Peak acceleration versus the peak velocity for all buildings triggered by the Zeerijp earthquake

The distribution of the dominant frequency of the vibration accelerations is analysed. The results of this analysis are given in Figures 5.8 – 5.10.

The frequency spectra of the measured acceleration signals (see Annex B for a selection of signals) show no significant frequency content above 15 Hz for the x- and y-channels of most sensors. The z-channels show a slightly higher frequency content up to 25 Hz for most sensors. As expected, the frequency spectra of the velocities (see Annex C) show a shift of the content to the lower frequencies with no significant content above 10 Hz for the x- and y-channels and above 20 Hz for the z-channel.

Dominant frequencies are on average 4 Hz for the x and y-channels, and 9 Hz for the z-channel. The 95% upper bound for the dominant frequency is 10 Hz for the x and y-channels and 18 Hz for the z-channel.
For the y- and z-channels of some sensors there is a narrow peak in the frequency spectrum at 50 Hz or 100 Hz. This peak is likely related to electric noise and its energy content is negligible. These values have been neglected in determining the dominant frequency statistics.

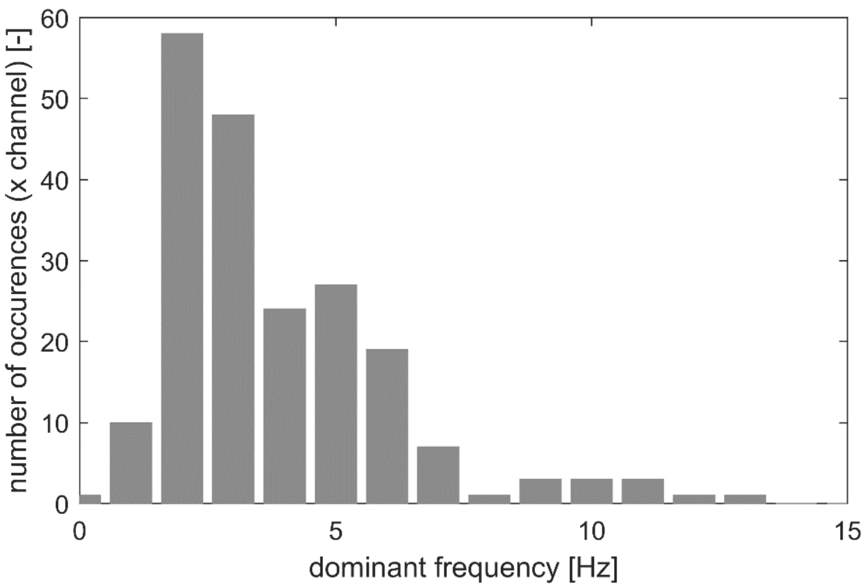

Figure 5.8: Distribution of dominant frequency of the vibration accelerations; x-direction for all buildings triggered by the Zeerijp earthquake

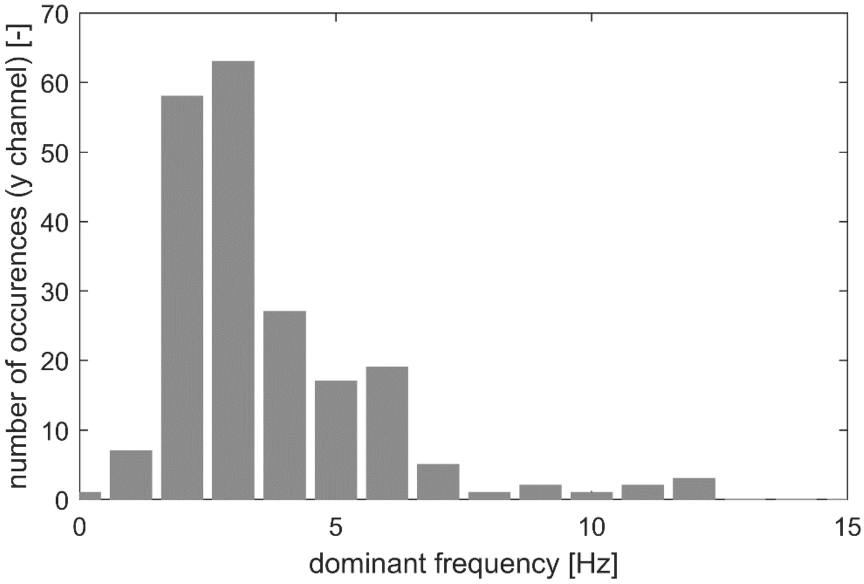

Figure 5.9: Distribution of dominant frequency of the vibration accelerations; y-direction for all buildings triggered by the Zeerijp earthquake

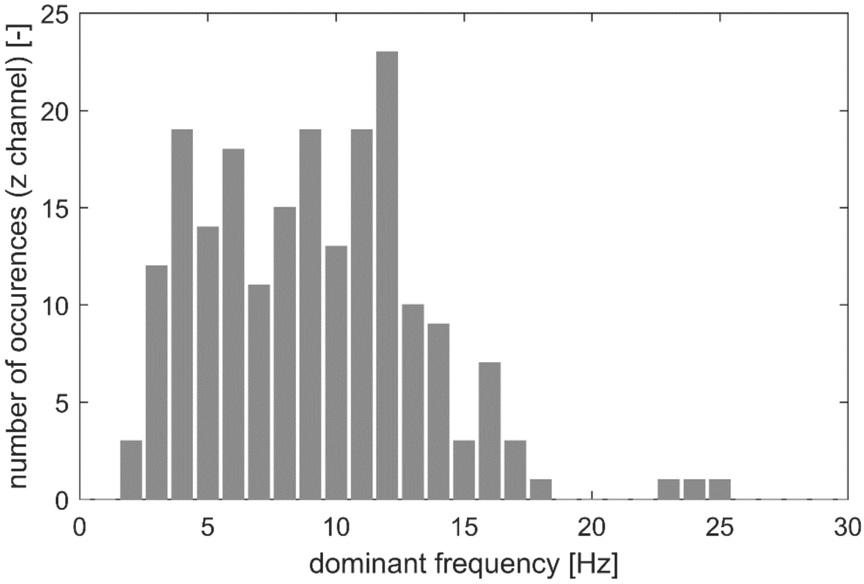

Figure 5.10: Distribution of dominant frequency of the vibration accelerations; z-direction for all buildings triggered by the Zeerijp earthquake

6 Framework analysis damage of buildings

6.1 General

During the installation of the sensors, an initial damage survey of the buildings has been executed (see TNO-report “Monitoring Network Building Vibrations”; Chapter 11 (ref [01])). The main aim of this damage survey was to classify the initial damage in the buildings according to the EMS-98 “European Seismological Scale” (see Figure 6.1 and Table 6.1). This classification has been used in many other damage studies across Europe.

The initial building damage survey was limited to a survey of the cracks in the external parts of the building facades, because this information is sufficient for the categorisation of the building damage according to the EMS-scale.

Classification of damage to masonry buildings	
	**Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)** Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
	**Grade 5: Destruction (very heavy structural damage)** Total or near total collapse.

Figure 6.1: Classification of damage for masonry buildings (EMS-98)

Table 6.1: Defined damages state of buildings

Damage state	Description
DS 0	No damage

DS 1	Negligible damage (“non-structural”)
DS 2	Moderate damage (“slight structural”)
DS 3	Substantial to heavy damage (“structural”)
DS 4	Very heavy damage
DS 5	Destruction

6.2 Repetitive building survey

After an earthquake, all buildings triggered by that earthquake have been surveyed again, in a similar way as the initial damage survey. The registration form used for this repetitive damage survey is given in Annex H.

During this repetitive damage survey cracks that were already present have been examined:
- to see if the length and/or the width has been increased
- to see if they are repaired in the meantime
- to see if repaired cracks have cracked again.

Also new cracks are reported, in the same way as during the initial damage survey.

Based on the results of the repetitive damage survey the damage state of the buildings after the earthquake has been determined.

6.3 Damage curves

Based on a comparison of the initial building damage state and the damage state after the earthquake, the effect of the earthquake on the individual buildings can be determined. Subsequently this effect can be related to the measured vibration level of the foundation during the earthquake.

The relation between vibration level and occurred damage can be characterized in different ways. In line with the SBR directive for vibration damage (ref [02]) the vibration level will be characterized by the peak velocity of the buildings. Therefore, damage curves have been setup based on the relation between the peak velocity of the building foundations and the damage state after the earthquake.

In the period between the previous damage survey and the current damage survey, other vibrations (triggers), higher than the vibrations caused by the earthquake, could have occurred in the buildings. This could be vibrations due to another earthquake, which took place in the intermediate period. This could also be triggers other than an earthquake. If these have occurred, the building owners were asked for the reason for their trigger.
If higher vibrations are measured in between the two executed damage surveys, it is first analyzed if these vibrations were only local, near the sensor (for example hitting the sensor), or for the whole building (for example traffic). If these vibrations were only local, they are not taken into account, but if these were for the whole building, that maximum measured building vibration has been used for the damage curves.

7 Repetitive damage survey buildings

The repetitive damage surveys have taken place from January to May 2018. The repetitive damage survey was done for a total of 197 houses.

The results of these repetitive damage surveys are given in Annex I. For each building this Annex provides the following information:

- The amount of cracks registered at the previous damage survey, for each of the three categories of crack width separately (category A < 1 mm; category B between 1 and 10 mm; category C > 10 mm).
- The amount of cracks that was repaired in the period between the previous damage survey and the repetitive damage survey.
- The amount of cracks with an increase in length and/or width, divided in cracks that remained in the same category of crack width and cracks which moved to a higher category.
- The amount of new cracks registered for each of the three categories of crack width A, B and C. In each category of crack width the new cracks are divided in cracks that were observed for the first time and cracks in already repaired cracks.

Note:

The purpose of the initial survey was to detect and record major cracks in the buildings, in order to determine the damage state (DS) of the buildings. At that time it was not intended to execute a total survey, including also the smallest cracks.
During the first repetitive damage surveys question raised, mainly about small cracks, whether these crack were already present or were caused by the earthquake. For this reason it was decided to record also minor cracks. As a consequence of this decision, at the first repetitive damage surveys much more cracks are recorded than at the initial damage survey.

Based on the results of the repetitive damage survey, the damage state of the buildings after the Zeerijp earthquake has been categorized again. The results of the categorization of the previous damage state and the damage state after the Zeerijp earthquake are presented in Table 7.1.

Table 7.1: Categorization of the previous damage state and the damage state at the repetitive damage survey

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z1	1,9	1	1
Z2	2,3	2	2'
Z3	12,9	1	1'
Z5	2,1	2	2'
Z7	1,9	0	1

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z8	4,7	1	1
Z9	2,2	2	2'
Z10	3,3	1	1'
Z11	2,0	2	2'
Z12	16,3	1	1'
Z13	14,4	1	1'
Z14	2,7	1	1'
Z15	2,4	1	1'
Z16	2,2	1	1'
Z17	12,6	1	1'
Z18	10,7	1	1
Z19	2,0	1	1'
Z20	1,6	0	0
Z21	1,4	1	1'
Z22	18,0	2	2
Z23	2,3	2	2'
Z24	2,5	1	1
Z25	5,0	1	1'
Z26	1,0	1	1'
Z27	1,2	1	1'
Z28	2,5	1	1'
Z29	3,0	1	1'
Z30	1,0	2	2'
Z31	11,3	1	1'
Z32	2,0	1	1
Z33	3,1	2	1'
Z34	1,4	1	1'
Z35	5,1	0	1
Z36	1,7	1	1'
Z37	1,8	1	1'
Z38	11,6	1	1
Z39	13,5	1	1'
Z40	27,2	1	1'
Z41	2,7	1	1'
Z42	1,1	1	1'
Z43	13,5	1	1'
Z44	8,5	1	1'
Z45	1,7	1	1'
Z47	5,2	0	1
Z48	2,0	2	2'

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z49	9,3	1	1'
Z50	2,8	1	1'
Z51	2,0	2	2'
Z52	2,5	1	1'
Z53	2,6	1	1'
Z54	1,1	0	1
Z55	1,9	2	2'
Z56	25,3	2	2
Z57	1,1	1	1
Z58	1,6	1	1'
Z59	1,6	1	1'
Z60	9,9	1	1
Z61	3,2	1	1
Z62	8,4	1	1'
Z63	1,1	0	0
Z64	1,5	2	2'
Z65	2,3	1	1'
Z66	3,0	1	1
Z67	1,8	1	1
Z68	1,1	1	1'
Z69	2,0	1	1'
Z70	3,9	1	1
Z71	2,8	1	1
Z72	1,8	2	2'
Z73	1,6	1	1'
Z74	10,9	2	2'
Z75	2,4	1	1
Z76	27,6	1	1
Z77	2,1	1	1
Z78	4,5	1	1'
Z79	1,8	1	1'
Z80	1,6	1	1
Z81	10,4	1	1'
Z82	1,8	1	1'
Z83	2,8	1	1
Z84	5,4	1	1'
Z85	4,8	1	1'
Z86	1,0	1	1'
Z87	1,9	1	1
Z88	2,2	1	1'

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z89	3,4	1	1'
Z90	1,7	1	1'
Z91	12,1	1	1
Z92	1,6	1	1'
Z93	22,0	1	1'
Z94	1,5	1	1
Z95	2,6	1	1'
Z96	1,0	2	2'
Z97	2,6	1	1'
Z98	1,1	1	1'
Z99	2,1	1	1'
Z100	3,6	1	1'
Z101	2,0	1	1'
Z102	2,6	1	1'
Z103	1,9	1	1
Z104	2,0	1	1'
Z105	3,5	1	1
Z106	2,3	1	1'
Z107	2,4	1	1
Z108	1,7	2	2'
Z109	2,7	1	1'
Z110	3,3	1	1
Z111	23,8	1	1'
Z112	4,7	1	1'
Z113	2,3	2	2'
Z114	12,8	1	1'
Z115	4,8	1	1'
Z116	16,1	1	1
Z117	4,0	0	1
Z118	2,9	0	1
Z119	13,7	2	2'
Z120	3,3	1	1'
Z121	10,8	1	1
Z122	4,1	1	1'
Z123	10,3	1	1'
Z124	2,5	1	1
Z125	11,3	1	1'
Z126	2,3	2	2
Z127	4,5	1	1'
Z128	12,8	1	1'

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z129	9,1	2	2'
Z130	3,0	1	1'
Z131	1,1	1	1
Z132	1,6	1	1'
Z133	2,4	1	1'
Z134	1,8	1	1'
Z135	2,5	0	1
Z136	1,8	1	1'
Z137	6,9	2	2'
Z138	4,0	1	1'
Z139	2,5	2	2
Z140	3,1	1	1
Z141	1,6	2	1'
Z142	9,2	1	1'
Z143	1,6	1	1'
Z144	3,3	0	0
Z145	2,1	2	2'
Z146	1,7	1	1'
Z147	4,4	1	1'
Z148	2,1	1	1'
Z149	6,7	1	1
Z150	6,4	1	1'
Z151	25,0	1	1'
Z152	1,6	1	1'
Z153	9,6	2	2'
Z154	2,7	1	1
Z155	2,4	1	1'
Z156	1,8	1	1'
Z158	2,4	1	1'
Z159	1,1	1	1'
Z160	5,8	1	1'
Z161	1,3	1	1'
Z162	2,9	0	1
Z163	2,5	1	1'
Z164	5,7	1	1'
Z165	3,6	0	0
Z166	2,2	1	1'
Z167	1,6	1	1'
Z168	1,1	1	1'
Z169	1,1	1	1'

Code	Peak vibration velocity $v_{x,y,max}$ (mm/s)	Damage state (DS)	
		At previous damage survey	At repetitive damage survey
Z170	1,0	2	2'
Z171	2,5	2	1'
Z172	2,2	1	1'
Z173	1,5	2	2'
Z174	5,2	2	2
Z175	1,1	1	1
Z176	1,7	1	1'
Z177	2,7	0	1
Z178	2,8	1	1
Z185	3,2	3	3'
Z187	2,2	1	1
Z193	1,1	1	1'
Z194	1,2	1	1'
Z195	2,1	0	1
Z196	1,1	2	2'
Z197	1,3	2	2'
Z198	1,3	0	1
Z199	3,1	1	1'
Z200	2,2	2	2'
Z201	4,1	3	3'
Z202	4,2	1	1'
Z203	3,5	2	2'
Z204	1,4	1	1'
Z205	2,0	1	1'
Z206	1,7	1	1
Z207 k	2,0	1	1
Z208 k	3,0	2	2'
Z209 k	3,0	1	1'
Z210 k	1,0	1	1
Z211	1,2	2	2'
Z212	13,2	1	1'
Z213	2,5	0	0

k - No vibration data due to temporary malfunctioning of the sensor; v_{max} estimated, based on distance to epicentre

8 Analysis repetitive damage survey

8.1 Amount of cracks

This Paragraph gives an analysis of the results of these repetitive damage surveys, as given in Annex I.

The situation of the 197 houses at the previous damage survey was as follows:

- In 16 (8%) houses no cracks were observed.
- In the other 181 houses a total amount of 2130 cracks was reported.
- These 2130 cracks were divided as follows over the crack width categories:
  - Category A (< 1 mm): 77%
  - Category B (1 – 10 mm): 22%
  - Category C (> 10 mm): 1%

The repetitive damage survey of 197 houses resulted in the following information:

- A total of 49 cracks has increased in length and/or width. This is 2% of the 2130 cracks already present at the previous damage survey.
- A total of 785 new cracks was reported. 95% of these new reported cracks were relatively small and short and belonged to crack width category A. None of the new cracks belonged to crack width category C.
- As already mentioned at the "note" in the former Chapter a part of the new reported cracks was already present at the initial damage survey.

In 78 houses cracks were repaired in the period between the previous damage survey and the repetitive damage survey, in total 476 cracks. In 22 of these houses (28%) repaired cracks showed new cracking. The total amount of new cracks in repaired ones is 39 (8%).

8.2 Normative vibration velocity

For the period between the previous damage survey and the repetitive damage survey, the houses triggered by the Zeerijp earthquake have been scanned for other triggers, exceeding the registered vibration velocity during the earthquake. If these higher triggers have occurred, it was checked if the owners of these houses have given an explanation for these triggers. Based on this information the following decisions were made, regarding the normative vibration velocity for the results of the damage survey:

- In case of a local vibration, such as mounting the sensor's cover lit or hitting the sensor, these triggers are not taken into account for the damage analysis.
- In case of a vibration for which it is likely that it has resulted in a vibration of the whole house, such as traffic or building activities in the neighborhood, these triggers are taken into account for the damage analysis.
- In case of an unknown reasons, vibration levels until 10 mm/s are taken into account for the damage analysis. Higher vibration levels are not taken into account.

An overview of the houses for which triggers have been registered exceeding the level of those registered during the earthquakes is given in Annex J. The results as presented in Annex J provide the following information:

- In 104 of the 197 houses triggers were recorded that have exceeded the vibration level of the earthquake. The following causes of the triggers were provided by the owners:
  - Traffic, causing vibration levels up to 10 mm/s.
  - Road construction works, causing vibration levels up to 4,3 mm/s.
  - Dropping an object in house, causing a vibration level of 2,2 mm/s.
  - Another earthquake, causing a vibration level up to 2,2 mm/s.
  - Hitting the sensor or calibrating of the sensor.
  - Unknown cause (reported as unknown or reported nothing).
- In 67 houses in which triggers were recorded that have exceeded the vibration level of the earthquake, it is expected that the triggers had an effect on the whole house. For these houses the higher triggers are taken into account, instead of the triggers of the earthquake.

8.3 Damage curves

The damage curves of the Zeerijp earthquake are given for the damage state categories DS 0 to DS 3 (Figure 8.1 – 8.4). The horizontal axis in these figures shows the maximum registered vibration velocity in horizontal direction in the period between the previous and the repetitive damage survey (see Table 7.1 and Annex J). The vertical axis shows the damage state categories according to the following scheme:

<u>Houses categorized in DS 0 at previous survey</u>
- DS 0→DS 0 = remained in DS 0
- DS 0→DS 1 = damage state increased to DS 1

<u>Houses categorized in DS 1 at previous survey</u>
- DS 1→DS 0 = repaired to DS 0 and remained in DS 0
- DS 1→DS 1 = remained in DS 1
- DS 1→DS 1' = remained in DS 1, but increase in amount and/or length and/or width of cracks
- DS 1→DS 2 = damage state increased to DS 2

<u>Houses categorized in DS 2</u>
- DS 2→DS 1 = repaired to DS 1 and remained in DS 1
- DS 2→DS 2 = remained in DS 2
- DS 2→DS 2' = remained in DS 2, but increase in amount and/or length and/or width of cracks
- DS 2→DS 3 = damage state increased to DS 3

<u>Houses categorized in DS 3</u>
- DS 3→DS 3 = remained in DS 3
- DS 3→DS 3' = remained in DS 3, but increase in amount and/or length and/or width of cracks

From the damage curves the following conclusions can be drawn:

- For a part of the houses originally categorised in damage state DS 0, the damage state has increased to DS 1. For these houses originally no cracks were reported and after the earthquake one or more. The other houses remained in damage state DS 0.
- For the houses originally categorised in damage state DS 0 there is no clear relation between the maximum vibration velocity and whether they remained in damage state DS 0 or have increased to damage state DS 1.
- For a part of the houses originally categorised in damage state DS 1-3, the amount of reported cracks has increased, however, this didn’t result in an increase of the damage state. The other houses remained in same damage state, without an increase of the amount of cracks.
- For the houses originally categorised in damage state DS 1-3 there is no clear relation between the maximum vibration velocity and whether the amount of reported cracks had increased or not.

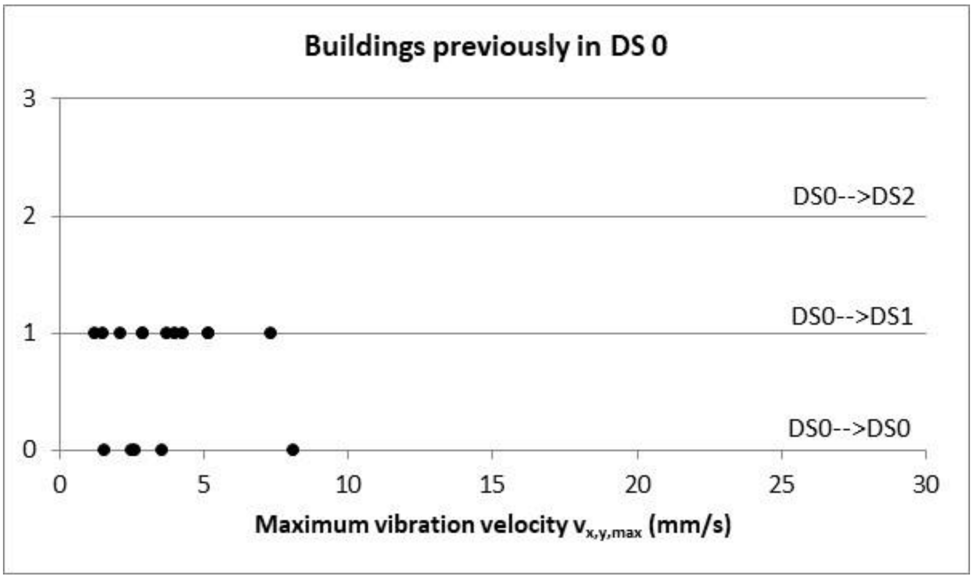

Figure 8.1: Damage state for houses categorised in DS 0 at previous survey

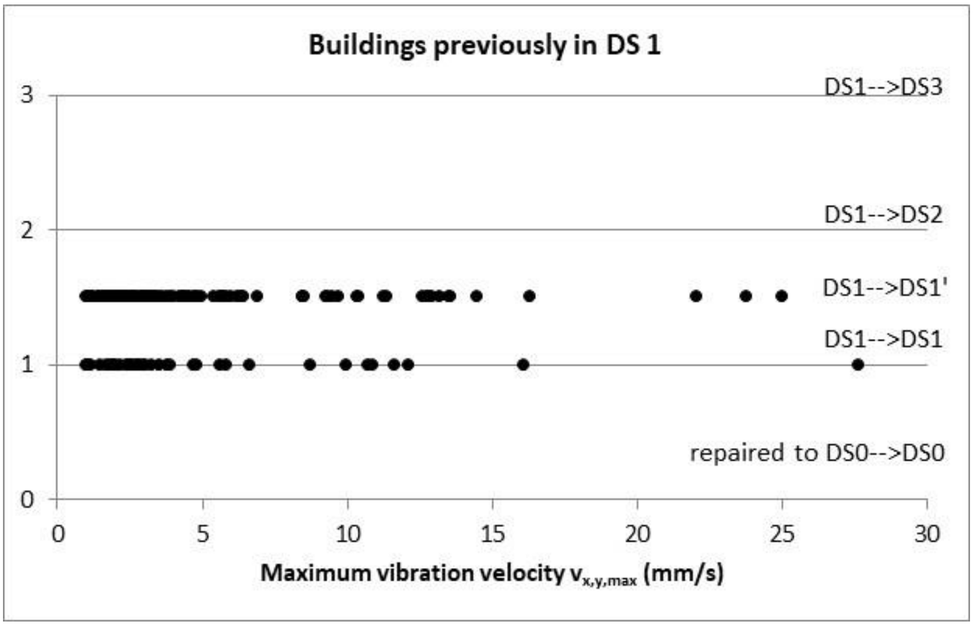

Figure 8.2: Damage state for houses categorised in DS 1 at previous survey

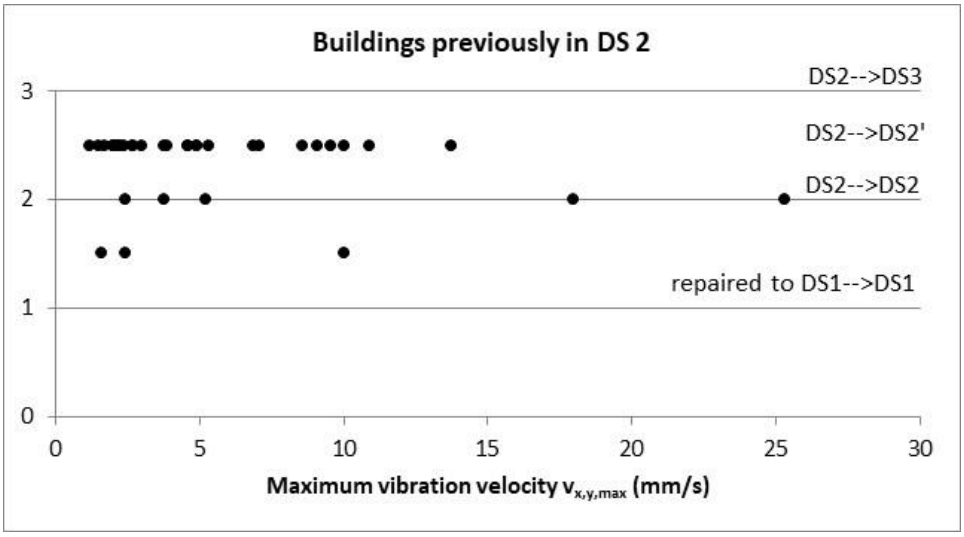

Figure 8.3: Damage state for houses categorised in DS 2 at previous survey

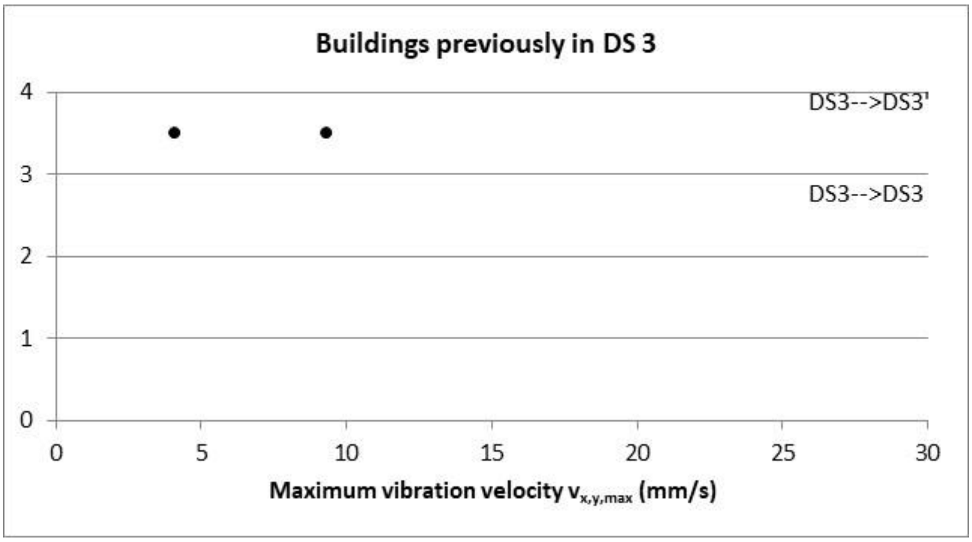

Figure 8.4: Damage state for houses categorised in DS 3 at previous survey

9 Conclusions

9.1 English version

TNO has analysed the effects of the Zeerijp earthquake of the 8th January 2018 on the buildings of the monitoring network. The analysis has resulted in the following conclusions.

Building vibrations

1. In 209 buildings of the monitoring network the maximum building vibration velocity at foundation level has exceeded the pre-set trigger of 1 mm/s.

2. The maximum measured foundation vibration acceleration (a_{max}) is 1.05 m/s^2 in the vertical direction and 1.52 m/s^2 in the horizontal direction.

3. The maximum measured foundation vibration velocity (v_{max}) is 7.0 mm/s in the vertical direction and 27.6 mm/s in the horizontal direction.

4. The horizontal component of the vibration velocity is mostly dominant over the vertical component. In case of the accelerations this is a little less obvious, but in most cases the vertical acceleration component is also dominant over the horizontal one.

5. For the x- and y-direction of the buildings, the dominant frequency of the vibration acceleration is on average 4 Hz. The dominant frequency for the z-direction is on average 9 Hz.

Repetitive damage survey

6. The analysis of the damage survey was executed for 197 houses.

7. For these 197 houses, a total amount of 2130 cracks was reported in the previous damage survey. The major part of these cracks (77%) had a maximum width of 1 mm (category A).

8. At the repetitive damage survey for 2% of these cracks an increase in length or width was reported.

9. A total of 785 new cracks was reported at the repetitive damage surveys. The majority of these newly reported cracks (95%) was relatively small and short (category A).

10. In 78 houses cracks were repaired in the period between the previous damage survey and the repetitive damage survey, in total 476 cracks. In 22 of these houses (28%) repaired cracks showed new cracking. The total amount of new cracks in repaired ones is 39 (8%).

11. For a part of the houses the amount of reported cracks at the repetitive damage survey has increased, in relation to the previous damage survey. However, for none of the houses that were initially (or at previous survey)

categorized in damage state DS 1-3, the earthquake has resulted in an increase of damage state.

12. There is found no clear relation between the maximum vibration velocity and whether the amount of reported cracks in the houses had increased or not.

9.2 Dutch version

TNO heeft de effecten geanalyseerd van de aardbeving in Zeerijp d.d. 8 januari 2018 op de gebouwen van het monitoringsnetwerk. Deze analyse heeft geleid tot de volgende conclusies.

Gebouwtrillingen

1. In 209 gebouwen van het monitoringsnetwerk heeft de maximale trillingssnelheid van de gebouwen op funderingsniveau de vooraf ingestelde triggerwaarde van 1 mm/s overschreden.

2. De maximaal gemeten versnelling van de trilling op funderingsniveau (a_{max}) is 1,05 m/s^2 in de verticale richting en 1,52 m/s^2 in de horizontale richting.

3. De maximaal gemeten trillingssnelheid op funderingsniveau (v_{max}) is 7,0 mm/s in de verticale richting en 27,6 mm/s in de horizontale richting.

4. De horizontale component van de trillingssnelheid is meestal dominant over de verticale component. Voor de versnelling is dit iets minder duidelijk, maar in de meeste gevallen is de verticale component van de versnelling ook dominant over de horizontale component.

5. Voor de x- en y-richting van de gebouwen is de dominante frequentie van de trillingsversnelling gemiddeld 4 Hz. De dominante frequentie voor de z-richting is gemiddeld 9 Hz.

Herhalingsopname schade

6. Voor 197 huizen is de schade opname geanalyseerd.

7. Voor deze 197 huizen waren bij de vorige schade opname in totaal 2.130 scheuren gerapporteerd. Het grootste deel van deze scheuren (77%) had een maximale wijdte van 1 mm (categorie A).

8. Bij de herhalingsopnamen werd bij 2% van deze scheuren een toename in de lengte of breedte gerapporteerd.

9. Bij de herhalingsopnamen werden in totaal 785 nieuwe scheuren gerapporteerd. De meerderheid van deze nieuw gerapporteerde scheuren (95%) was relatief smal en kort (categorie A).

10. In de periode tussen de vorige schade opname en de herhalingsopname waren in 78 huizen scheuren hersteld, totaal 476 scheuren. In 22 van deze huizen (28%) vertoonden gerepareerde scheuren een nieuwe scheur. Het totaal aantal nieuwe scheuren in eerder gerepareerde scheuren is 39 (8%).

11. Voor een deel van de huizen is de hoeveelheid gerapporteerde scheuren bij de herhalingsopname toegenomen ten opzichte van de vorige schade opname. Echter, voor geen van de huizen die aanvankelijk (of bij een eerdere opname) waren ingedeeld in schadeklasse DS 1-3 heeft de aardbeving geresulteerd in een toename van de schadeklasse.

12. Er is geen duidelijke relatie gevonden tussen de maximale trillingssnelheid en een eventuele toename van het aantal gerapporteerde scheuren in de huizen.

10 References

[01] TNO-report 2015 R10501 “Monitoring Network Building Vibrations”

[02] SBR Trillingsrichtlijn A: “Schade aan bouwwerken: 2017”

[03] SBR guide line B: “Meet- en beoordelingsrichtlijn. Hinder voor personen in gebouwen, 2002”

[04] TNO-report 2015 R10604 “Monitoring Network Building Vibrations – Analysis Earthquake 30-09-2014 Garmerwolde”

[05] TNO-report 2015 R11382 “Monitoring Network Building Vibrations – Analysis Earthquakes 05-11-2014 (Zandeweer), 30-12-2014 (Woudbloem) and 06-01-2015 (Wirdum)”

[06] TNO-report 2016 R10421 “Monitoring Network Building Vibrations – Analysis Earthquakes 30-09-2015 (Hellum)”

[07] TNO-report 2018 R10275 “Monitoring Network Building Vibrations – Analysis Earthquakes 27-05-2017 (Slochteren)”

11 Signature

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Signature Research Manager Structural Reliability a.i.:

Dr.ir. A.H.J.M. Vervuurt

A Background information

Table A.1: Building typologies

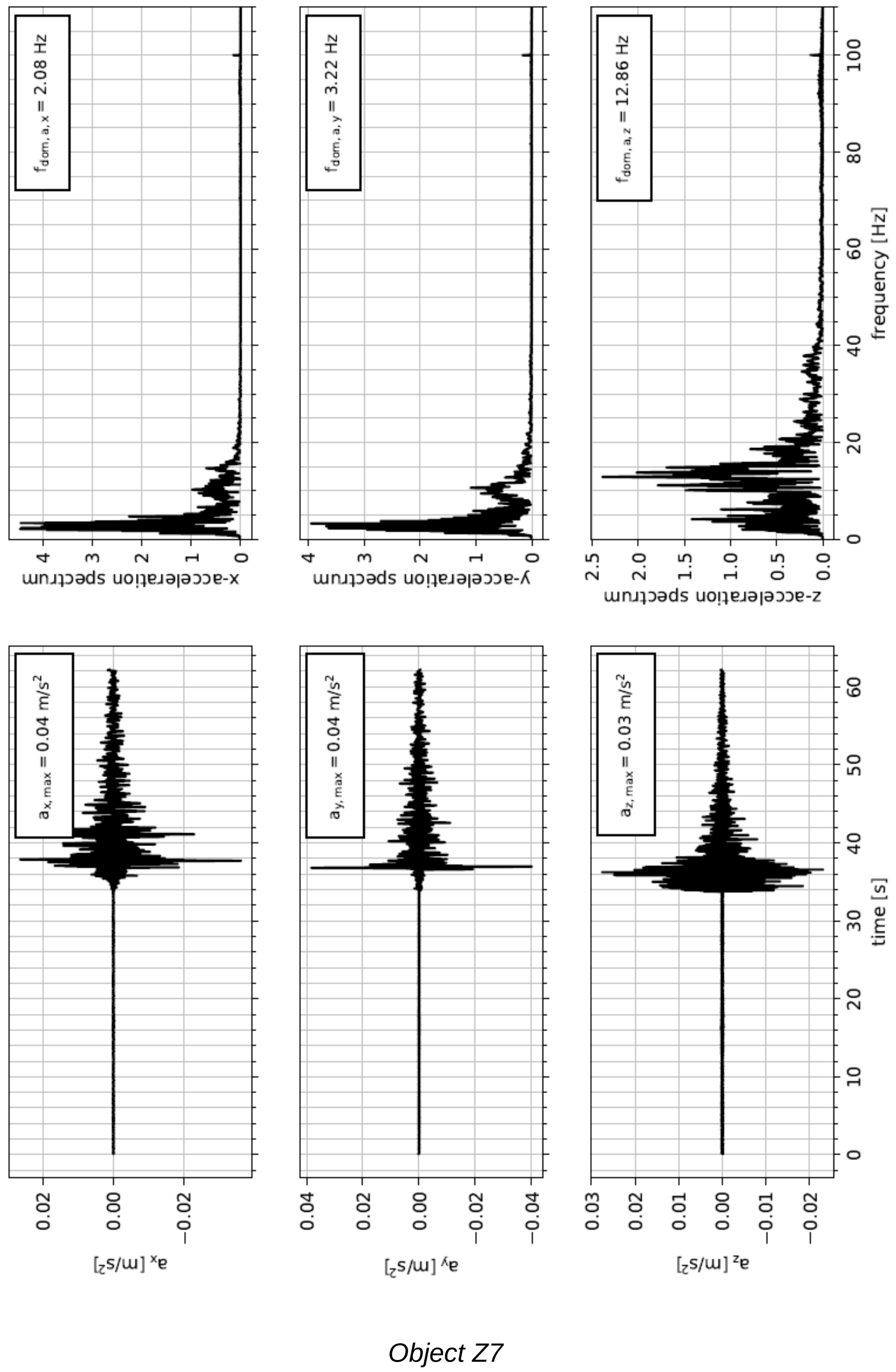
No.	Building type	Foundation	Type of floor
1	Terraced building - corner	(Piles)[1]	(Concrete)[1]
2	Terraced building – no corner	(Piles)[1]	(Concrete)[1]
3	Semi-detached	(Piles)[1]	(Concrete)[1]
4	Detached <1940	No piles	Combination wood/concrete
5		No piles	Wood
6		No piles	Concrete
7	Detached 1941-1975	No piles	--
8	Detached >1975	Piles	Concrete
9		No piles	Concrete
10	Other (not a house; most of them public buildings)		

)[1] Not all buildings fulfil this pre-set properties (see TNO-report 2015 R10501 “Monitoring Network Building Vibrations” [01])

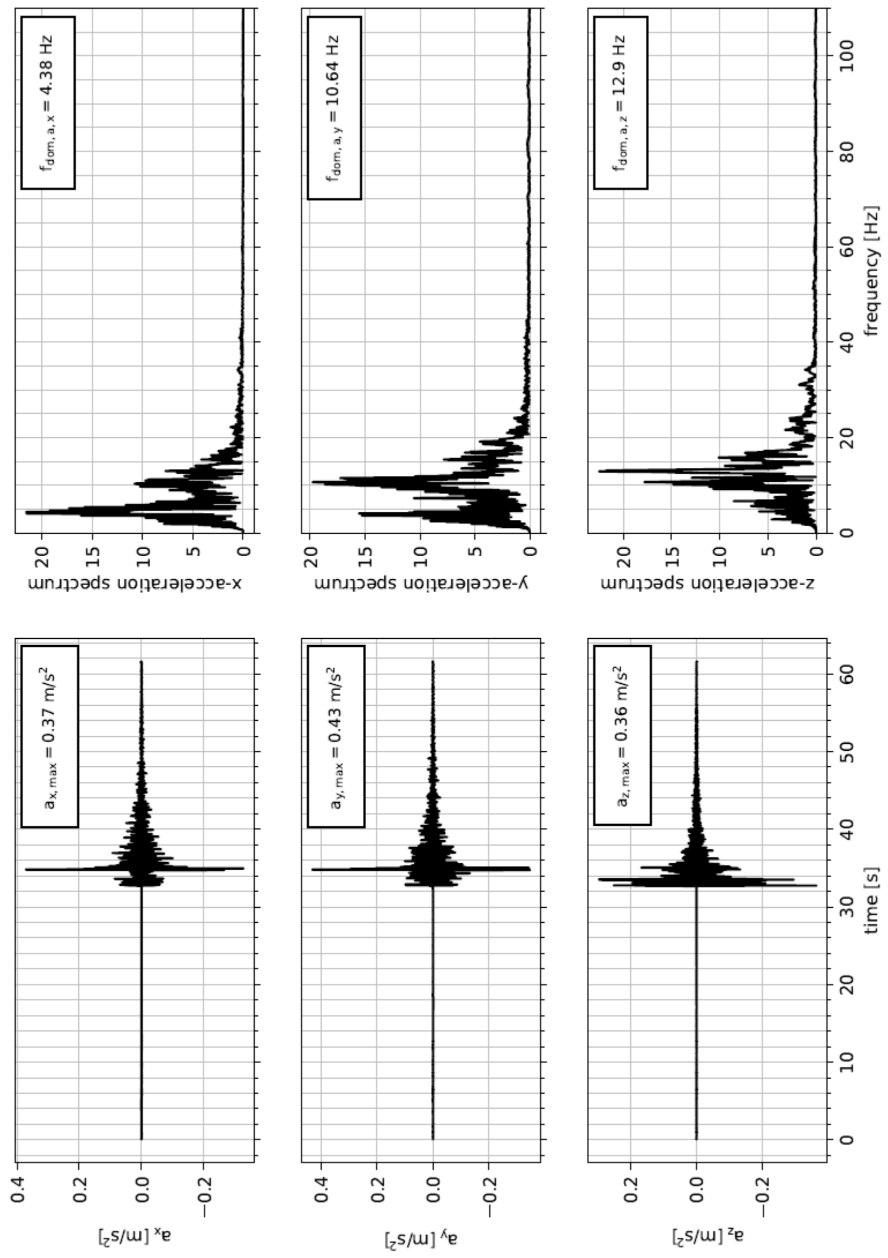
B Vibration signals – acceleration

This Annex gives an example of the measured vibration acceleration signals. For four objects, with different levels of acceleration, the following graphs are given:

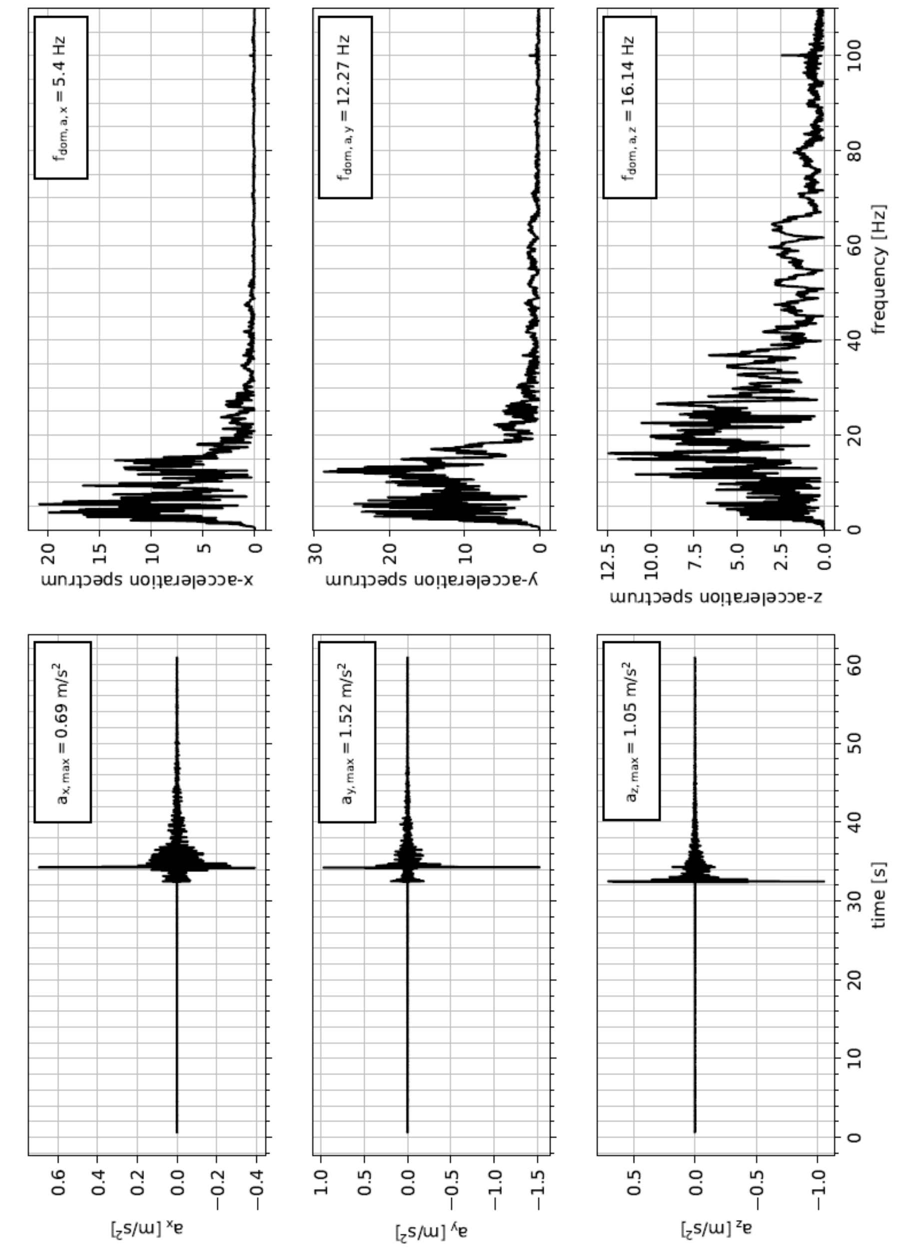
- Measured acceleration (a_x, a_y, a_z)
- Distribution of the frequency ($f_{dom,a,x}$,$f_{dom,a,y}$,$f_{dom,a,z}$)



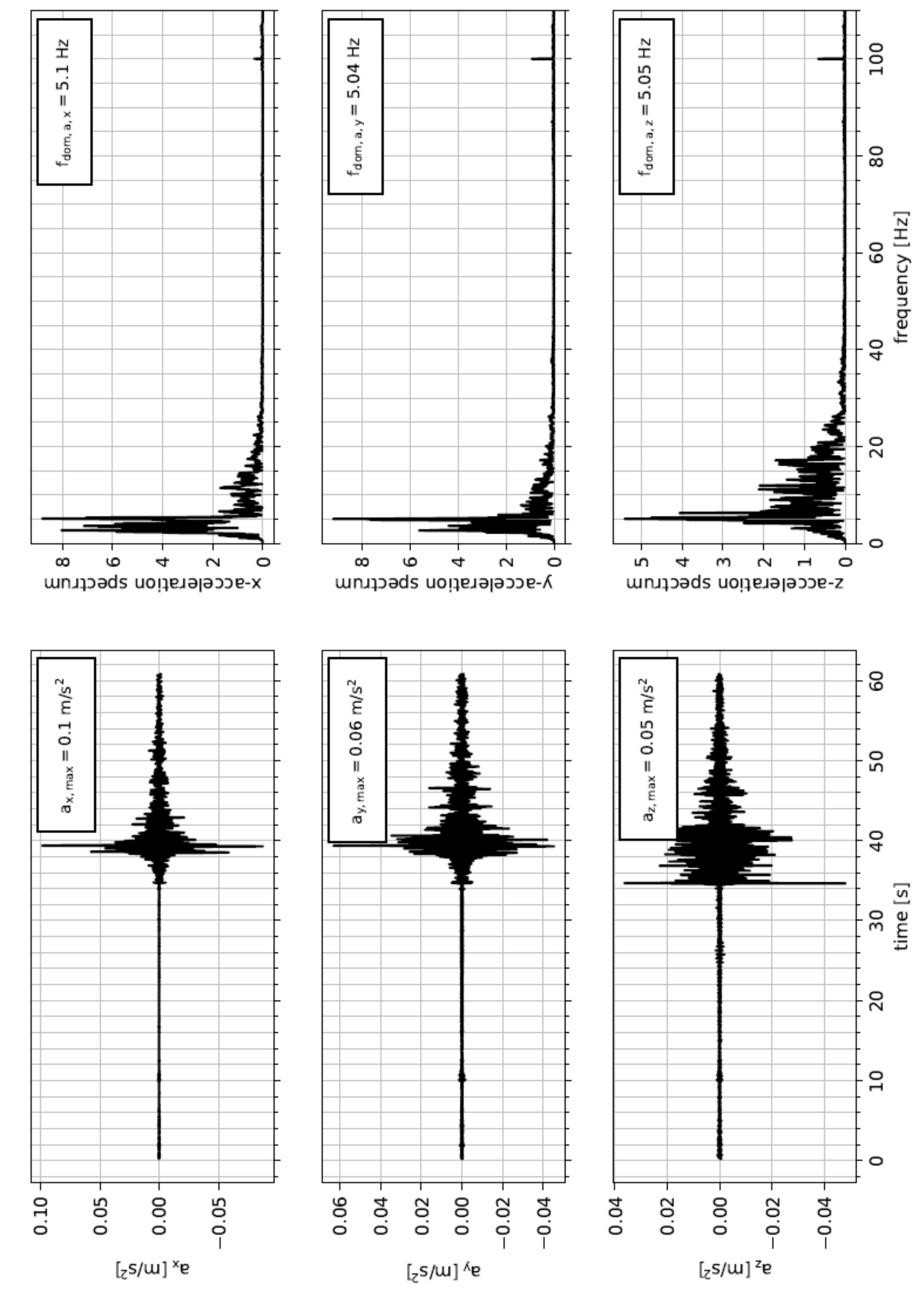
Object Z7


$f_{dom,a,x} = 4.38$ Hz
$f_{dom,a,y} = 10.64$ Hz
$f_{dom,a,z} = 12.9$ Hz
x-acceleration spectrum
y-acceleration spectrum
z-acceleration spectrum
frequency [Hz]
$a_{x,max} = 0.37$ m/s^2
$a_{y,max} = 0.43$ m/s^2
$a_{z,max} = 0.36$ m/s^2
a_x [m/s^2]
a_y [m/s^2]
a_z [m/s^2]
time [s]

Object Z153


f_dom, a, x = 5.4 Hz
f_dom, a, y = 12.27 Hz
f_dom, a, z = 16.14 Hz
x-acceleration spectrum
y-acceleration spectrum
z-acceleration spectrum
frequency [Hz]
a_x, max = 0.69 m/s²
a_y, max = 1.52 m/s²
a_z, max = 1.05 m/s²
a_x [m/s²]
a_y [m/s²]
a_z [m/s²]
time [s]

Object Z156

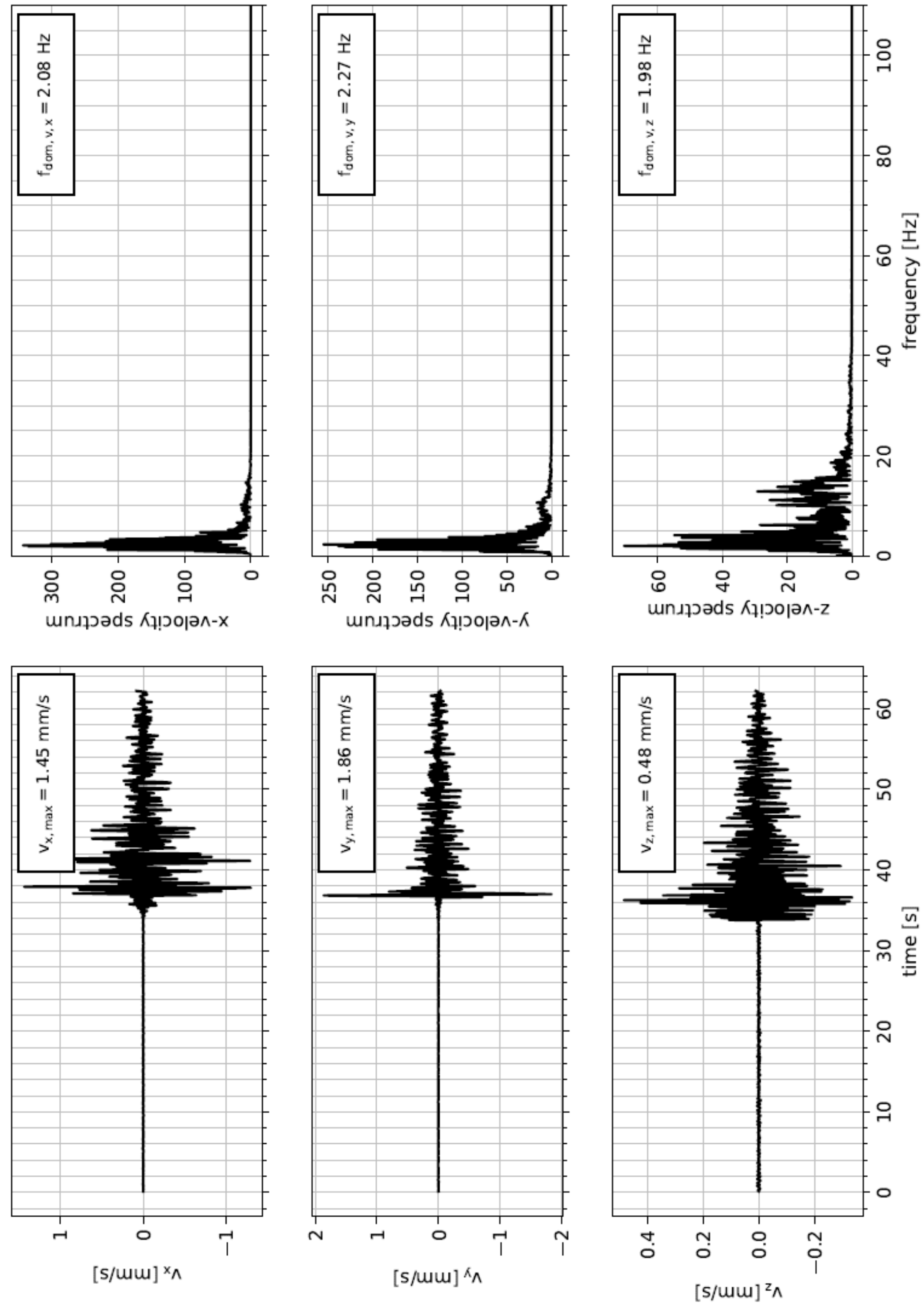

$f_{dom,a,x} = 5.1$ Hz
$f_{dom,a,y} = 5.04$ Hz
$f_{dom,a,z} = 5.05$ Hz
x-acceleration spectrum
y-acceleration spectrum
z-acceleration spectrum
frequency [Hz]
$a_{x,max} = 0.1$ m/s²
$a_{y,max} = 0.06$ m/s²
$a_{z,max} = 0.05$ m/s²
a_x [m/s²]
a_y [m/s²]
a_z [m/s²]
time [s]

Object Z147

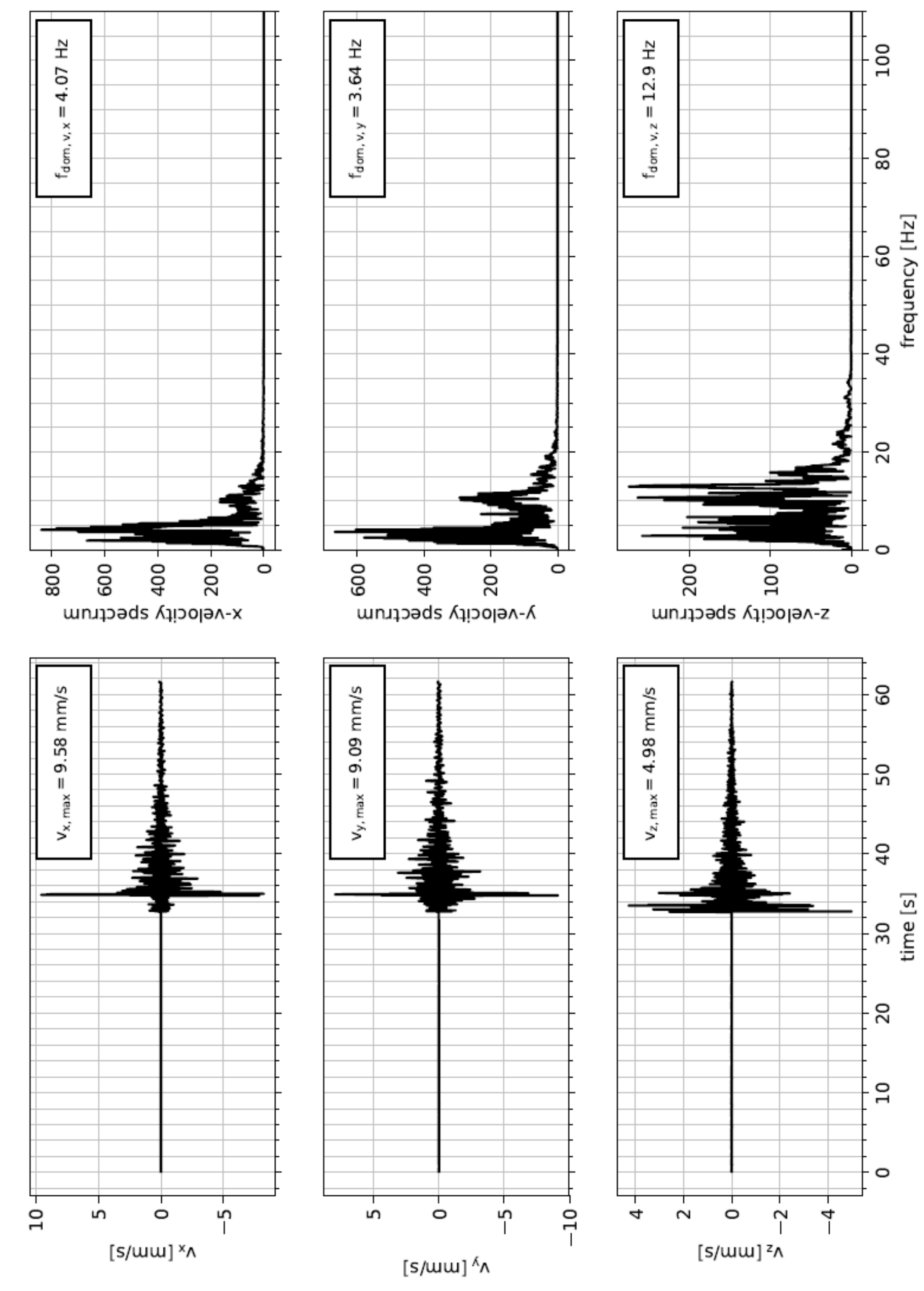
C Vibration signals – velocity

This Annex gives an example of the vibration velocity signals. For four objects, with different levels of velocity, the following graphs are given:

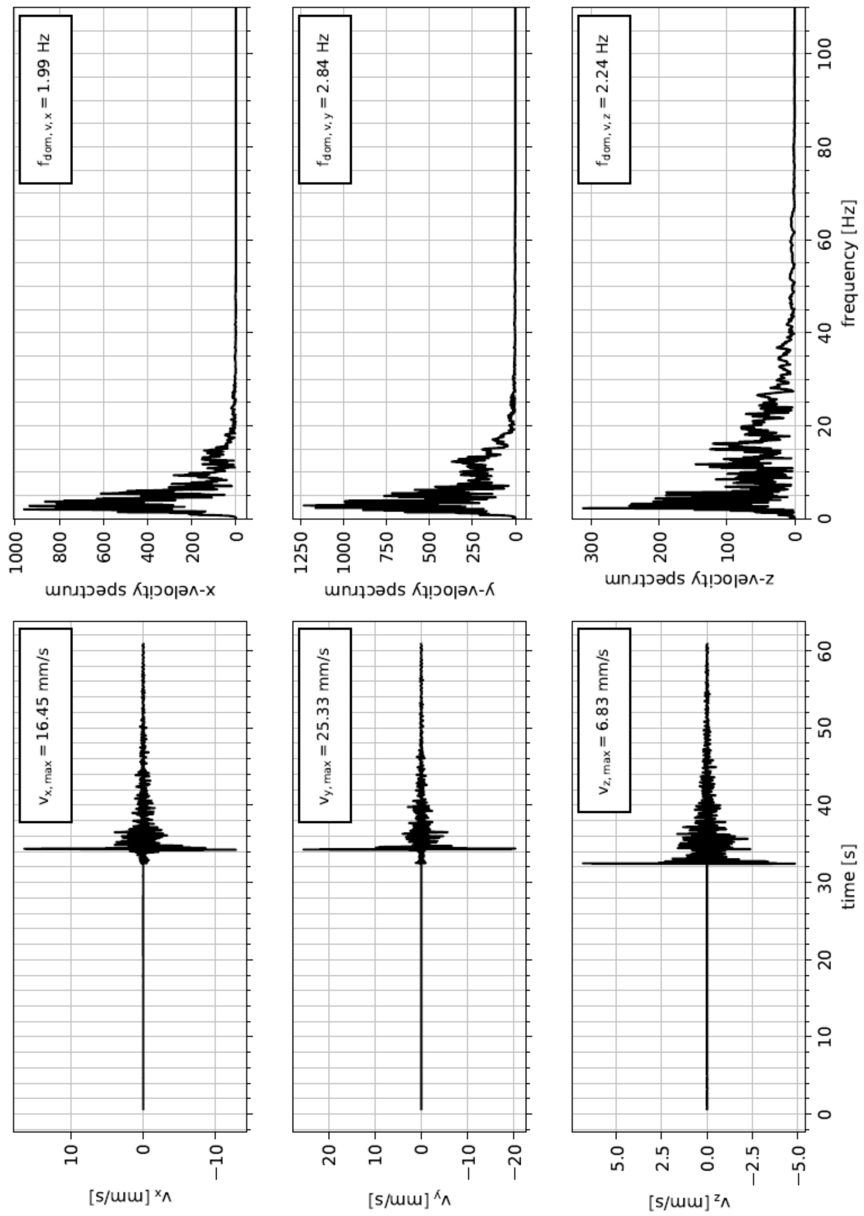
- Measured velocity (v_x, v_y, v_z)
- Distribution of the frequency ($f_{dom,v,x}$,$f_{dom,v,y}$,$f_{dom,v,z}$)



Object Z7

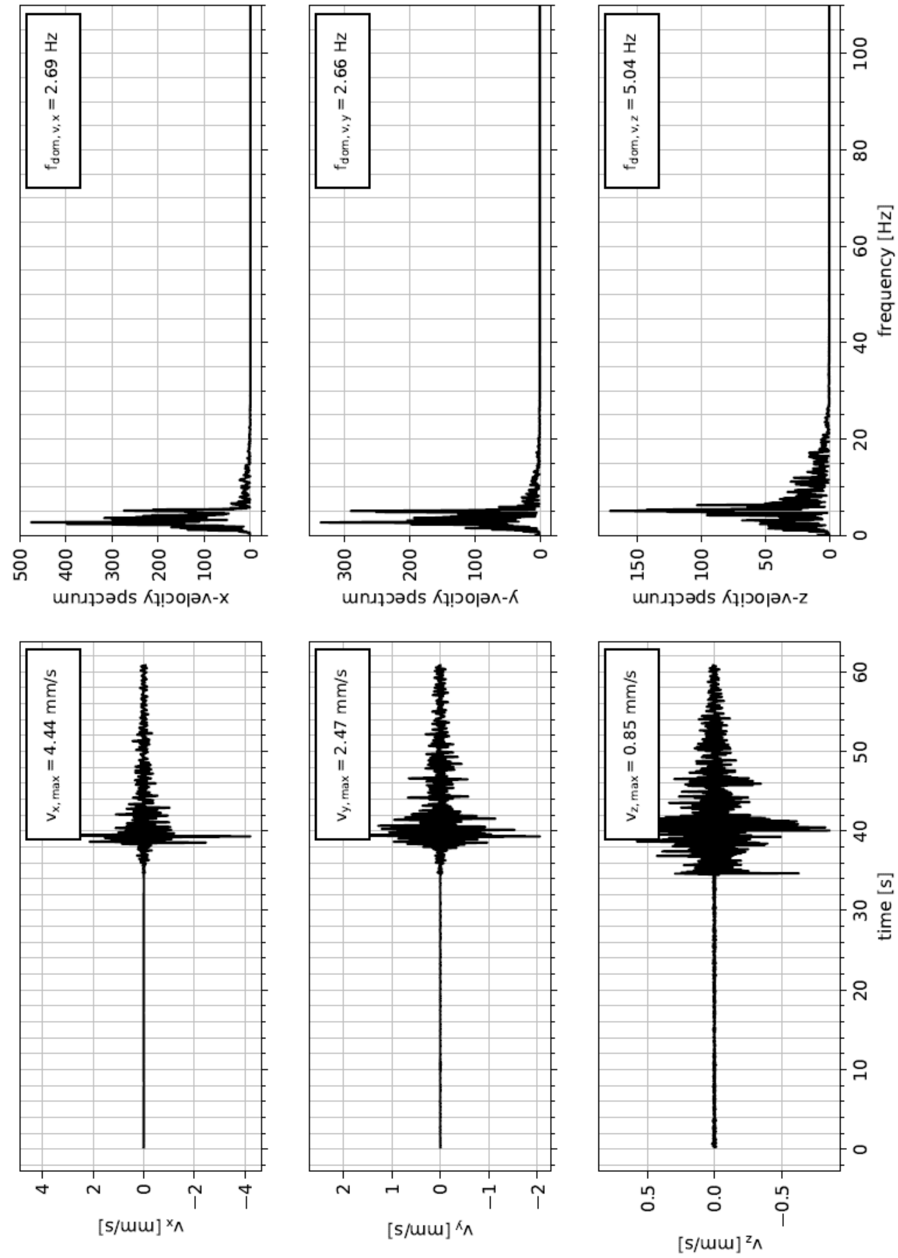

f_dom,v,x = 4.07 Hz
f_dom,v,y = 3.64 Hz
f_dom,v,z = 12.9 Hz
x-velocity spectrum
y-velocity spectrum
z-velocity spectrum
frequency [Hz]
v_x,max = 9.58 mm/s
v_y,max = 9.09 mm/s
v_z,max = 4.98 mm/s
v_x [mm/s]
v_y [mm/s]
v_z [mm/s]
time [s]

Object Z153



f_dom, v, x = 1.99 Hz
f_dom, v, y = 2.84 Hz
f_dom, v, z = 2.24 Hz
x-velocity spectrum
y-velocity spectrum
z-velocity spectrum
frequency [Hz]
v_x, max = 16.45 mm/s
v_y, max = 25.33 mm/s
v_z, max = 6.83 mm/s
v_x [mm/s]
v_y [mm/s]
v_z [mm/s]
time [s]

Object Z156



$f_{dom, v, x}$ = 2.69 Hz
$f_{dom, v, y}$ = 2.66 Hz
$f_{dom, v, z}$ = 5.04 Hz
x-velocity spectrum
y-velocity spectrum
z-velocity spectrum
frequency [Hz]
$v_{x, max}$ = 4.44 mm/s
$v_{y, max}$ = 2.47 mm/s
$v_{z, max}$ = 0.85 mm/s
v_x [mm/s]
v_y [mm/s]
v_z [mm/s]
time [s]

Object Z147

D Vibration characteristics regarding acceleration

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\|a(t)\|_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z1	0.05	0.04	0.03	0.05	0.05	4.2	3.3	12.0
Z2	0.06	0.08	0.07	0.08	0.08	5.9	2.7	8.5
Z3	0.38	0.52	0.41	0.52	0.56	11.6	2.6	9.7
Z4	0.03	0.07	0.02	0.07	0.07	3.3	6.6	16.4
Z5	0.05	0.04	0.03	0.05	0.05	3.2	2.6	4.4
Z6	0.03	0.02	0.03	0.03	0.03	1.9	2.2	9.2
Z7	0.04	0.04	0.03	0.04	0.04	2.1	3.2	12.9
Z8	0.10	0.12	0.10	0.12	0.12	3.1	2.7	6.7
Z9	0.04	0.05	0.04	0.05	0.05	3.2	3.0	12.0
Z10	0.16	0.16	0.12	0.16	0.21	10.5	6.8	14.4
Z11	0.06	0.04	0.10	0.06	0.10	7.2	6.5	9.4
Z12	0.28	0.98	0.43	0.98	0.99	4.3	7.5	13.3
Z13	0.52	0.73	0.50	0.73	0.78	10.8	9.7	9.1
Z14	0.14	0.06	0.16	0.14	0.16	6.9	7.6	12.4
Z15	0.06	0.03	0.01	0.06	0.06	3.8	4.5	4.3
Z16	0.10	0.07	0.09	0.10	0.10	7.8	6.8	13.2
Z17	0.13	0.51	0.20	0.51	0.51	4.3	4.4	6.3
Z18	0.38	0.22	0.31	0.38	0.38	6.1	6.0	13.2
Z19	0.04	0.03	0.04	0.04	0.05	2.1	2.0	14.0
Z20	0.03	0.02	0.01	0.03	0.03	3.9	4.0	4.1
Z21	0.04	0.03	0.08	0.04	0.08	2.3	2.0	12.0
Z22	0.23	0.85	0.44	0.85	0.85	4.8	3.1	9.5
Z23	0.07	0.06	0.03	0.07	0.07	6.5	6.4	11.1
Z24	0.05	0.05	0.04	0.05	0.06	6.0	2.4	11.3
Z25	0.12	0.10	0.11	0.12	0.12	2.6	3.2	10.3
Z26	0.02	0.02	0.02	0.02	0.03	2.8	2.4	12.2
Z27	0.01	0.03	0.01	0.03	0.03	6.0	3.8	8.4
Z28	0.06	0.05	0.01	0.06	0.06	2.8	5.9	5.9
Z29	0.06	0.04	0.04	0.06	0.07	3.9	6.8	6.7
Z30	0.02	0.02	0.01	0.02	0.03	2.6	2.6	5.0
Z31	0.39	0.47	0.38	0.47	0.49	7.4	12.4	9.2
Z32	0.04	0.06	0.11	0.06	0.11	2.6	2.6	14.3
Z33	0.08	0.08	0.11	0.08	0.11	5.9	4.6	10.0
Z34	0.03	0.01	0.01	0.03	0.03	3.9	3.8	5.4
Z35	0.09	0.13	0.04	0.13	0.16	3.9	3.2	8.5

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\|a(t)\|_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z36	0.04	0.03	0.04	0.04	0.04	2.4	2.3	12.3
Z37	0.03	0.03	0.03	0.03	0.03	2.0	2.1	11.7
Z38	0.29	0.53	0.26	0.53	0.54	6.0	5.6	9.0
Z39	0.28	0.47	0.57	0.47	0.59	9.1	8.7	9.2
Z40	0.24	0.66	0.35	0.66	0.70	3.0	3.0	14.1
Z41	0.07	0.07	0.04	0.07	0.07	3.8	4.1	6.6
Z42	0.03	0.02	0.03	0.03	0.03	2.7	2.6	11.5
Z43	0.34	0.58	0.32	0.58	0.71	13.4	12.6	13.7
Z44	0.43	0.25	0.36	0.43	0.46	11.3	11.4	9.4
Z45	0.04	0.05	0.03	0.05	0.05	4.4	3.9	4.7
Z46	0.07	0.06	0.04	0.07	0.09	5.8	4.1	16.9
Z47	0.15	0.21	0.11	0.21	0.21	9.2	6.3	12.4
Z48	0.03	0.02	0.03	0.03	0.04	6.4	6.6	8.8
Z49	0.34	0.31	0.34	0.34	0.35	2.5	4.4	16.6
Z50	0.07	0.08	0.04	0.08	0.11	5.7	5.2	11.8
Z51	0.04	0.02	0.02	0.04	0.04	3.7	2.7	3.7
Z52	0.11	0.07	0.09	0.11	0.11	5.2	4.3	14.2
Z53	0.08	0.08	0.10	0.08	0.10	3.2	4.9	7.6
Z54	0.02	0.02	0.02	0.02	0.03	2.5	1.8	10.0
Z55	0.04	0.04	0.05	0.04	0.05	2.2	2.0	12.9
Z56	0.69	1.52	1.05	1.52	1.62	5.4	12.3	16.1
Z57	0.03	0.03	0.02	0.03	0.03	7.8	3.0	12.5
Z58	0.03	0.03	0.03	0.03	0.04	1.6	2.0	10.4
Z59	0.03	0.03	0.01	0.03	0.04	2.7	4.4	7.9
Z60	0.48	0.29	0.27	0.48	0.51	6.2	6.0	8.8
Z61	0.02	0.05	0.02	0.05	0.05	3.3	3.6	3.7
Z62	0.26	0.25	0.14	0.26	0.35	3.2	2.3	13.5
Z63	0.02	0.03	0.02	0.03	0.03	3.2	2.6	12.4
Z64	0.03	0.03	0.03	0.03	0.04	2.3	2.2	9.0
Z65	0.02	0.03	0.04	0.03	0.04	2.4	3.0	12.7
Z66	0.03	0.06	0.01	0.06	0.06	3.5	3.6	6.7
Z67	0.02	0.03	0.01	0.03	0.04	2.8	2.5	9.0
Z68	0.02	0.02	0.01	0.02	0.02	1.7	1.9	9.0
Z69	0.02	0.05	0.02	0.05	0.05	3.7	4.1	4.8
Z70	0.12	0.11	0.03	0.12	0.13	4.5	4.1	6.0
Z71	0.08	0.07	0.12	0.08	0.12	3.2	4.5	10.6
Z72	0.03	0.01	0.02	0.03	0.03	2.7	--	--
Z73	0.02	0.03	0.04	0.03	0.04	3.1	3.2	8.1
Z74	0.52	0.57	0.33	0.57	0.69	7.5	7.1	8.1

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\|a(t)\|_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z75	0.05	0.03	0.02	0.05	0.05	4.0	3.6	6.0
Z76	0.18	0.59	0.31	0.59	0.61	2.7	5.3	16.8
Z77	0.04	0.04	0.02	0.04	0.05	3.8	3.3	4.3
Z78	0.12	0.04	0.03	0.12	0.12	4.0	4.1	4.9
Z79	0.01	0.03	0.02	0.03	0.03	2.0	3.3	8.7
Z80	0.03	0.03	0.02	0.03	0.04	2.3	2.4	--
Z81	0.36	0.27	0.27	0.36	0.37	5.1	9.7	6.0
Z82	0.03	0.03	0.04	0.03	0.04	1.8	2.0	9.9
Z83	0.06	0.03	0.02	0.06	0.07	3.4	3.1	16.0
Z84	0.10	0.16	0.04	0.16	0.18	5.2	4.0	11.7
Z85	0.11	0.04	0.03	0.11	0.11	3.0	3.1	6.4
Z86	0.02	0.03	0.01	0.03	0.03	1.7	2.1	9.0
Z87	0.03	0.01	0.02	0.03	0.03	2.9	3.1	12.8
Z88	0.07	0.06	0.04	0.07	0.08	5.9	5.8	17.5
Z89	0.12	0.09	0.10	0.12	0.12	6.2	3.7	17.5
Z90	0.03	0.02	0.02	0.03	0.03	2.6	2.6	10.0
Z91	0.42	0.24	0.31	0.42	0.45	5.1	6.0	9.0
Z92	0.04	0.04	0.04	0.04	0.05	1.8	5.2	7.0
Z93	0.13	0.53	0.51	0.53	0.55	5.5	5.0	14.3
Z94	0.03	0.03	0.01	0.03	0.04	3.2	3.8	3.3
Z95	0.03	0.06	0.02	0.06	0.07	3.7	3.7	11.1
Z96	0.02	0.03	0.01	0.03	0.04	2.9	1.8	2.9
Z97	0.05	0.03	0.04	0.05	0.05	3.0	2.6	13.8
Z98	0.01	0.03	0.01	0.03	0.03	4.3	4.3	4.2
Z99	0.08	0.07	0.11	0.08	0.11	3.1	7.4	13.3
Z100	0.10	0.12	0.16	0.12	0.16	6.6	6.7	12.8
Z101	0.05	0.06	0.05	0.06	0.07	6.1	5.1	6.7
Z102	0.06	0.07	0.03	0.07	0.07	6.8	2.6	6.8
Z103	0.07	0.05	0.03	0.07	0.07	4.0	3.8	7.2
Z104	0.03	0.02	0.04	0.03	0.04	3.1	2.9	12.0
Z105	0.09	0.05	0.13	0.09	0.13	3.2	3.5	13.0
Z106	0.05	0.04	0.04	0.05	0.07	6.2	3.2	4.6
Z107	0.08	0.04	0.02	0.08	0.08	3.8	4.2	7.3
Z108	0.03	0.04	0.03	0.04	0.04	2.8	3.4	15.1
Z109	0.06	0.08	0.04	0.08	0.10	6.8	4.7	6.5
Z110	0.10	0.07	0.05	0.10	0.11	6.3	4.2	6.1
Z111	0.87	1.43	0.55	1.43	1.67	7.2	11.5	10.3
Z112	0.10	0.11	0.07	0.11	0.12	4.7	3.9	12.3
Z113	0.03	0.04	0.08	0.04	0.08	3.5	3.0	10.9

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\|a(t)\|_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z114	0.46	0.28	0.23	0.46	0.49	5.6	6.4	15.7
Z115	0.10	0.15	0.10	0.15	0.17	11.0	3.4	17.0
Z116	0.33	0.61	0.26	0.61	0.63	97.4	5.6	97.4
Z117	0.13	0.07	0.08	0.13	0.13	4.1	3.2	11.0
Z118	0.09	0.07	0.05	0.09	0.09	2.8	6.2	12.9
Z119	0.28	0.64	0.48	0.64	0.66	9.3	6.7	18.3
Z120	0.07	0.05	0.13	0.07	0.13	3.7	3.7	7.5
Z121	0.32	0.29	0.14	0.32	0.39	5.8	5.3	5.4
Z122	0.07	0.07	0.30	0.07	0.31	4.5	3.5	14.1
Z123	0.26	0.38	0.23	0.38	0.40	6.1	2.6	9.0
Z124	0.10	0.09	0.09	0.10	0.11	3.7	7.2	16.7
Z125	0.33	0.33	0.36	0.33	0.36	10.3	4.3	9.2
Z126	0.05	0.07	0.04	0.07	0.08	5.2	5.1	5.4
Z127	0.07	0.12	0.03	0.12	0.14	2.9	3.4	12.4
Z128	0.13	0.31	0.19	0.31	0.34	4.9	3.3	13.6
Z129	0.24	0.34	0.42	0.34	0.42	3.0	3.7	5.6
Z130	0.06	0.03	0.04	0.06	0.07	3.3	3.8	7.8
Z131	0.02	0.02	0.02	0.02	0.03	5.2	3.9	12.3
Z132	0.03	0.01	0.02	0.03	0.03	2.3	2.4	3.9
Z133	0.04	0.05	0.02	0.05	0.06	3.1	3.8	7.1
Z134	0.02	0.04	0.04	0.04	0.04	2.3	2.3	8.4
Z135	0.06	0.05	0.10	0.06	0.10	2.3	2.4	12.5
Z136	0.02	0.03	0.01	0.03	0.03	3.5	3.6	5.9
Z137	0.26	0.24	0.25	0.26	0.32	8.5	4.3	10.3
Z138	0.08	0.10	0.04	0.10	0.12	3.1	3.1	5.1
Z139	0.02	0.04	0.02	0.04	0.04	2.8	2.8	3.6
Z140	0.04	0.06	0.03	0.06	0.07	2.6	2.7	3.6
Z141	0.03	0.03	0.01	0.03	0.03	4.2	2.3	4.3
Z142	0.28	0.27	0.29	0.28	0.31	5.1	5.0	23.3
Z143	0.06	0.04	0.06	0.06	0.06	4.0	4.3	10.3
Z144	0.11	0.11	0.09	0.11	0.12	3.0	3.9	13.3
Z145	0.01	0.03	0.03	0.03	0.03	2.4	2.2	11.6
Z146	0.03	0.02	0.02	0.03	0.03	2.3	2.9	11.8
Z147	0.10	0.06	0.05	0.10	0.12	5.1	5.0	5.1
Z148	0.03	0.02	0.03	0.03	0.04	2.7	3.0	12.5
Z149	0.14	0.14	0.13	0.14	0.16	2.8	3.1	12.8
Z150	0.12	0.14	0.15	0.14	0.15	3.1	3.2	5.4
Z151	0.15	0.59	0.44	0.59	0.61	5.5	5.1	14.2
Z152	0.04	0.03	0.03	0.04	0.04	4.1	3.2	6.6

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\lvert a(t) \rvert_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z153	0.37	0.43	0.36	0.43	0.52	4.4	10.6	12.9
Z154	0.07	0.12	0.10	0.12	0.12	6.6	6.8	11.7
Z155	0.10	0.06	0.06	0.10	0.11	6.6	3.5	6.5
Z156	0.06	0.04	0.10	0.06	0.10	7.0	2.6	10.1
Z157	0.01	0.04	0.06	0.04	0.07	1.9	2.0	11.9
Z158	0.05	0.05	0.04	0.05	0.06	4.1	3.8	11.0
Z159	0.02	0.02	0.02	0.02	0.02	2.4	2.1	9.4
Z160	0.17	0.18	0.12	0.18	0.25	4.4	5.0	10.0
Z161	0.02	0.03	0.01	0.03	0.04	3.2	2.9	8.6
Z162	0.07	0.07	0.06	0.07	0.07	2.4	2.8	---
Z163	0.03	0.04	0.02	0.04	0.05	2.8	3.6	11.6
Z164	0.05	0.13	0.03	0.13	0.14	5.1	5.1	4.9
Z165	0.09	0.09	0.09	0.09	0.10	2.5	2.4	11.0
Z166	0.07	0.06	0.10	0.07	0.10	2.8	3.0	10.5
Z167	0.04	0.05	0.04	0.05	0.06	4.1	4.1	6.4
Z168	0.03	0.03	0.02	0.03	0.04	3.6	6.8	8.8
Z169	0.02	0.03	0.02	0.03	0.03	2.6	3.6	11.2
Z170	0.02	0.02	0.02	0.02	0.03	2.9	2.9	2.6
Z171	0.01	0.05	0.01	0.05	0.05	2.2	2.4	4.8
Z172	0.04	0.02	0.03	0.04	0.04	2.3	3.3	--
Z173	0.03	0.04	0.02	0.04	0.04	5.0	3.0	14.2
Z174	0.12	0.03	0.11	0.12	0.12	2.1	3.1	12.6
Z175	0.02	0.02	0.01	0.02	0.02	2.8	2.1	10.9
Z176	0.02	0.03	0.01	0.03	0.03	2.4	2.5	3.8
Z177	0.06	0.03	0.03	0.06	0.06	2.5	2.6	5.0
Z178	0.08	0.06	0.07	0.08	0.08	5.4	6.2	6.2
Z179	0.02	0.03	0.01	0.03	0.03	12.6	3.1	5.4
Z180	0.27	0.43	0.36	0.43	0.44	6.5	2.4	8.4
Z181	0.03	0.02	0.02	0.03	0.03	2.0	2.7	10.3
Z182	0.03	0.04	0.04	0.04	0.05	2.8	2.3	3.8
Z183	0.07	0.06	0.04	0.07	0.09	3.8	3.5	5.2
Z184	0.03	0.09	0.05	0.09	0.09	5.1	5.2	3.9
Z185	0.08	0.09	0.06	0.09	0.09	3.1	3.3	5.9
Z185.2	0.08	0.10	0.04	0.10	0.11	3.3	3.1	7.5
Z186	0.04	0.04	0.03	0.04	0.05	2.8	2.8	11.1
Z187	0.05	0.06	0.01	0.06	0.08	5.7	4.1	25.8
Z188	0.03	0.01	0.01	0.03	0.03	2.9	2.7	3.0
Z189	0.03	0.03	0.01	0.03	0.03	5.1	2.7	24.3
Z190	0.02	0.02	0.01	0.02	0.03	3.7	4.0	4.4

Object	$a_{x,max}$ (m/s²)	$a_{y,max}$ (m/s²)	$a_{z,max}$ (m/s²)	$a_{x,y,max}$ (m/s²)	$\|a(t)\|_{max}$ (m/s²)	$f_{a,dom,x}$ (Hz)*	$f_{a,dom,y}$ (Hz)*	$f_{a,dom,z}$ (Hz)*
Z191	0.05	0.09	0.04	0.09	0.10	3.9	4.0	4.9
Z192	0.02	0.02	0.02	0.02	0.02	3.4	3.4	12.9
Z193	0.01	0.02	0.01	0.02	0.02	4.3	2.2	4.2
Z194	0.03	0.01	0.01	0.03	0.03	0.9	0.8	3.6
Z195.1	0.03	0.04	0.06	0.04	0.06	3.4	4.0	16.7
Z195.2	0.02	0.04	0.04	0.04	0.04	3.4	4.0	6.8
Z196	0.03	0.03	0.02	0.03	0.03	2.4	2.7	4.2
Z197	0.04	0.03	0.02	0.04	0.05	4.2	3.2	7.1
Z198	0.02	0.02	0.01	0.02	0.03	2.6	4.4	3.9
Z199	0.06	0.08	0.04	0.08	*0.10*	6.6	6.7	6.6
Z200	0.04	0.03	0.02	0.04	0.05	2.8	2.9	3.7
Z201	0.04	0.06	0.03	0.06	0.06	1.7	2.6	11.5
Z202	0.14	0.11	0.04	0.14	0.15	5.5	2.4	7.7
Z203	0.13	0.09	0.05	0.13	0.14	5.8	2.3	5.8
Z204	0.02	0.01	0.01	0.02	0.03	2.4	2.6	9.1
Z205	0.03	0.09	0.04	0.09	0.10	5.2	4.8	8.4
Z206	0.03	0.04	0.01	0.04	0.04	4.0	4.1	4.9
Z211	0.01	0.03	0.01	0.03	0.03	3.0	2.9	9.5
Z212	0.70	0.28	0.44	0.70	0.70	7.8	7.5	9.2
Z213	0.01	0.05	0.01	0.05	0.05	2.2	2.4	4.9

*) An explanation of these values is given in Chapter 5

E Vibration characteristics regarding velocity

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z1	1.93	1.70	0.44	1.93	2.21	2.0	3.3	4.7
Z2	2.29	2.19	1.07	2.29	2.41	2.3	2.7	8.5
Z3	6.31	12.91	4.15	12.91	13.50	2.0	2.6	5.6
Z4	1.02	0.86	0.55	1.02	1.06	3.3	2.3	3.7
Z5	2.04	2.12	0.65	2.12	2.46	1.8	2.6	4.3
Z6	0.87	1.12	0.85	1.12	1.26	1.7	1.4	1.7
Z7	1.45	1.86	0.48	1.86	1.92	2.1	2.3	2.0
Z8	3.82	4.69	1.00	4.69	5.60	1.4	2.7	2.3
Z9	1.71	2.16	0.77	2.16	2.62	2.4	1.9	4.9
Z10	2.89	3.35	1.25	3.35	3.93	4.3	1.4	6.2
Z11	2.04	1.20	1.77	2.04	2.06	2.7	2.8	6.9
Z12	5.81	16.31	6.12	16.31	16.40	3.1	3.2	3.2
Z13	11.12	14.45	5.20	14.45	14.55	3.1	2.5	9.1
Z14	2.67	1.69	2.67	2.67	2.93	2.5	2.7	3.8
Z15	2.37	1.03	0.40	2.37	2.38	2.2	2.6	2.3
Z16	2.23	1.95	1.54	2.23	2.25	3.1	3.2	6.7
Z17	2.97	12.59	4.07	12.59	12.62	4.3	1.9	2.8
Z18	10.70	5.26	3.79	10.70	11.62	1.8	2.7	6.1
Z19	1.98	1.44	0.64	1.98	1.99	2.1	1.9	2.8
Z20	1.56	1.04	0.24	1.56	1.84	3.9	2.2	1.6
Z21	1.41	1.35	1.14	1.41	1.66	2.3	2.0	9.2
Z22	5.67	17.96	5.12	17.96	18.03	4.8	3.1	5.6
Z23	1.96	2.35	0.69	2.35	2.35	2.0	2.4	2.4
Z24	1.63	2.55	0.96	2.55	2.57	3.4	2.4	2.4
Z25	4.96	3.41	1.46	4.96	5.31	2.6	1.4	2.9
Z26	0.95	0.78	0.43	0.95	1.11	2.8	2.4	2.5
Z27	0.49	1.23	0.25	1.23	1.30	2.5	2.9	3.5
Z28	2.50	1.79	0.27	2.50	2.71	2.8	1.6	5.9
Z29	3.00	1.28	0.68	3.00	3.11	3.9	2.7	6.7
Z30	1.02	0.94	0.44	1.02	1.36	1.5	2.6	2.7
Z31	10.93	11.34	4.09	11.34	11.94	3.1	3.7	9.2
Z32	1.54	1.96	1.01	1.96	2.00	2.6	2.6	3.8
Z33	2.62	3.09	1.17	3.09	3.10	3.1	2.4	3.4
Z34	1.43	0.47	0.26	1.43	1.43	3.9	3.8	2.7
Z35	3.26	5.14	0.70	5.14	6.08	3.9	3.2	3.6

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z36	1.66	1.45	0.69	1.66	1.72	2.4	2.3	2.7
Z37	1.26	1.79	0.50	1.79	1.86	2.0	1.6	3.1
Z38	8.27	11.62	3.73	11.62	12.09	2.3	2.1	9.0
Z39	5.42	13.53	6.96	13.53	14.41	2.3	2.4	9.1
Z40	9.41	27.22	4.67	27.22	28.53	2.5	2.6	5.2
Z41	1.80	2.67	0.95	2.67	2.84	3.8	3.2	5.4
Z42	1.10	0.89	0.43	1.10	1.17	1.9	2.2	3.9
Z43	5.01	13.50	4.08	13.50	13.95	2.1	2.3	6.4
Z44	8.46	5.87	4.44	8.46	9.81	2.6	2.0	6.1
Z45	1.61	1.73	0.67	1.73	1.80	4.4	3.0	4.7
Z46	2.26	2.21	0.67	2.26	3.08	3.3	4.1	4.1
Z47	3.45	5.17	2.11	5.17	5.19	1.8	2.4	3.4
Z48	2.01	0.79	0.84	2.01	2.13	3.0	2.4	3.2
Z49	9.29	8.34	4.30	9.29	10.14	2.5	2.2	9.2
Z50	2.84	2.83	0.62	2.84	4.01	5.7	2.6	4.4
Z51	2.03	1.01	0.72	2.03	2.04	1.8	1.8	3.7
Z52	2.48	1.75	1.19	2.48	2.69	2.9	2.8	2.6
Z53	2.58	2.33	1.57	2.58	3.09	3.2	2.8	7.6
Z54	1.11	0.83	0.42	1.11	1.13	2.5	1.8	4.1
Z55	1.79	1.92	0.73	1.92	1.93	2.2	2.0	3.6
Z56	16.45	25.33	6.83	25.33	26.68	2.0	2.8	2.2
Z57	0.65	1.12	0.25	1.12	1.13	2.4	2.8	2.5
Z58	1.65	1.56	0.57	1.65	2.12	1.6	2.0	3.8
Z59	1.62	1.04	0.30	1.62	1.78	1.4	1.4	2.5
Z60	9.94	7.96	3.85	9.94	10.83	2.3	2.5	8.8
Z61	0.85	3.23	0.39	3.23	3.26	2.5	2.6	3.7
Z62	7.75	8.43	1.97	8.43	11.20	1.9	2.3	2.6
Z63	1.06	0.94	0.36	1.06	1.17	2.3	2.6	1.9
Z64	1.48	1.43	0.50	1.48	1.89	2.3	2.2	3.2
Z65	1.01	2.27	0.55	2.27	2.43	1.7	1.8	3.1
Z66	1.18	2.98	0.39	2.98	3.09	3.5	3.5	2.5
Z67	0.79	1.78	0.21	1.78	1.90	2.0	2.5	2.8
Z68	0.98	1.06	0.17	1.06	1.21	1.7	1.9	1.5
Z69	0.71	2.03	0.62	2.03	2.06	3.0	1.8	3.7
Z70	3.11	3.91	0.82	3.91	4.02	4.5	4.1	3.8
Z71	2.76	2.74	1.78	2.76	2.80	3.0	2.3	10.6
Z72	1.84	0.47	0.52	1.84	1.90	2.7	2.8	5.2
Z73	0.93	1.60	0.55	1.60	1.61	3.1	3.2	2.8
Z74	10.92	10.66	3.68	10.92	12.82	7.5	7.1	7.5

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z75	2.38	1.20	0.44	2.38	2.62	2.6	2.1	3.6
Z76	6.25	27.62	4.05	27.62	28.38	2.7	2.3	3.0
Z77	2.12	1.66	0.35	2.12	2.53	2.2	3.3	3.1
Z78	4.53	1.75	0.58	4.53	4.79	2.3	4.1	4.9
Z79	0.88	1.78	0.48	1.78	1.80	2.0	1.9	2.1
Z80	1.56	1.50	0.37	1.56	1.70	2.3	1.7	3.0
Z81	10.38	7.51	3.20	10.38	10.64	3.7	2.6	6.0
Z82	1.18	1.81	0.69	1.81	2.03	1.8	2.0	3.9
Z83	2.81	1.60	0.44	2.81	3.17	3.4	3.1	3.6
Z84	3.54	5.38	0.69	5.38	6.38	5.2	2.7	2.7
Z85	4.81	1.25	0.56	4.81	4.88	3.0	3.1	2.5
Z86	0.76	1.04	0.23	1.04	1.30	1.7	1.4	2.8
Z87	1.87	0.76	0.38	1.87	1.90	1.9	1.9	2.9
Z88	2.17	1.21	0.74	2.17	2.18	2.3	2.7	3.1
Z89	2.96	3.39	1.34	3.39	3.70	3.6	2.4	6.5
Z90	1.66	0.70	0.49	1.66	1.70	1.6	1.7	1.9
Z91	12.09	6.77	4.09	12.09	13.50	2.6	2.3	9.0
Z92	1.55	1.31	0.71	1.55	1.94	1.8	2.0	3.2
Z93	4.66	22.04	6.39	22.04	22.38	2.0	1.7	2.1
Z94	1.50	1.49	0.29	1.50	1.80	3.2	2.3	3.3
Z95	1.66	2.56	0.30	2.56	2.86	3.7	2.7	2.8
Z96	1.05	1.03	0.37	1.05	1.21	1.6	1.8	2.9
Z97	2.61	1.55	0.53	2.61	2.67	2.0	1.9	2.3
Z98	0.54	1.12	0.26	1.12	1.22	3.0	4.3	4.2
Z99	1.93	2.06	1.64	2.06	2.11	3.1	3.6	6.7
Z100	3.56	3.50	2.14	3.56	3.88	3.0	2.7	12.8
Z101	1.99	1.38	0.55	1.99	2.35	6.1	1.9	3.6
Z102	1.51	2.59	0.71	2.59	2.71	2.4	2.4	6.8
Z103	1.74	1.88	0.70	1.88	2.29	3.8	2.7	3.7
Z104	1.97	1.13	0.53	1.97	2.27	1.8	1.4	12.0
Z105	3.54	1.62	1.62	3.54	3.72	3.2	2.3	4.1
Z106	1.32	2.32	0.74	2.32	2.45	2.2	3.2	4.6
Z107	2.44	1.24	0.60	2.44	2.46	3.7	4.2	3.8
Z108	1.07	1.74	0.66	1.74	1.82	2.8	2.6	5.4
Z109	2.32	2.73	0.88	2.73	3.58	3.9	3.0	6.5
Z110	3.33	1.79	0.84	3.33	3.40	6.3	2.9	6.1
Z111	18.09	23.77	6.24	23.77	26.02	3.7	2.9	3.5
Z112	3.14	4.74	0.90	4.74	5.13	4.7	3.9	3.4
Z113	1.29	2.30	1.53	2.30	2.50	2.6	3.0	4.0

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z114	12.75	8.79	3.00	12.75	13.33	2.6	3.4	3.7
Z115	2.89	4.80	1.27	4.80	5.12	3.6	3.4	3.5
Z116	4.70	16.14	3.30	16.14	16.22	1.9	2.3	3.2
Z117	4.00	2.34	1.01	4.00	4.02	3.8	3.2	4.3
Z118	2.87	2.05	0.86	2.87	2.92	1.9	2.1	2.3
Z119	5.46	13.74	4.52	13.74	13.96	3.2	2.5	6.1
Z120	3.34	1.53	1.09	3.34	3.37	3.7	3.7	7.5
Z121	10.79	10.85	1.74	10.85	14.34	4.7	5.3	5.4
Z122	2.49	2.74	4.08	2.74	4.10	4.5	2.8	12.0
Z123	7.18	10.34	3.52	10.34	10.70	2.2	2.6	9.0
Z124	2.53	2.25	0.96	2.53	2.75	3.7	3.7	4.6
Z125	5.42	11.25	3.93	11.25	11.62	2.6	2.4	9.2
Z126	1.73	2.29	0.79	2.29	2.48	2.2	2.4	5.4
Z127	2.34	4.47	0.55	4.47	4.85	2.9	2.3	2.7
Z128	3.73	12.80	1.80	12.80	12.90	2.3	2.0	2.8
Z129	8.37	9.10	4.80	9.10	11.38	3.0	1.8	5.6
Z130	2.98	1.15	0.49	2.98	3.04	3.3	3.1	7.8
Z131	1.03	1.14	0.30	1.14	1.38	3.0	2.6	2.8
Z132	1.57	0.94	0.56	1.57	1.63	2.3	2.4	3.9
Z133	1.88	2.38	0.50	2.38	2.63	2.6	2.1	2.6
Z134	1.35	1.85	0.69	1.85	1.89	2.3	2.3	3.9
Z135	2.46	1.73	1.62	2.46	2.49	2.1	2.0	12.5
Z136	0.87	1.77	0.39	1.77	1.96	3.5	3.6	2.4
Z137	6.48	6.87	3.84	6.87	8.72	1.9	2.3	5.7
Z138	3.11	4.02	0.83	4.02	4.96	3.1	3.1	5.1
Z139	0.74	2.45	0.47	2.45	2.45	2.8	2.2	3.6
Z140	1.87	3.05	0.45	3.05	3.57	2.6	2.7	3.6
Z141	1.58	1.44	0.30	1.58	1.85	3.0	2.3	3.6
Z142	8.98	9.24	2.21	9.24	11.08	3.8	5.0	2.5
Z143	1.57	0.65	1.22	1.57	1.58	2.4	4.3	3.7
Z144	3.35	2.56	1.03	3.35	3.38	3.0	3.5	2.4
Z145	0.56	2.05	0.57	2.05	2.11	1.6	2.2	2.3
Z146	1.71	1.03	0.39	1.71	1.82	2.0	2.0	1.6
Z147	4.44	2.47	0.85	4.44	5.08	2.7	2.7	5.0
Z148	2.12	1.04	0.47	2.12	2.36	1.9	2.1	3.9
Z149	5.78	6.65	1.48	6.65	7.72	2.4	3.1	4.7
Z150	4.05	6.37	1.54	6.37	7.41	3.1	3.2	5.4
Z151	4.99	25.00	5.73	25.00	25.55	1.8	1.8	5.1
Z152	1.62	1.26	0.70	1.62	1.72	2.6	3.2	5.2

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z153	9.58	9.09	4.98	9.58	12.13	4.1	3.6	12.9
Z154	1.90	2.70	1.73	2.70	2.73	3.0	6.8	6.8
Z155	2.36	2.09	1.36	2.36	2.92	3.3	3.5	6.5
Z156	1.37	1.51	1.83	1.51	1.83	2.8	2.6	10.1
Z157	0.98	0.72	0.47	0.98	1.08	1.9	1.3	3.7
Z158	2.39	1.34	0.70	2.39	2.40	4.0	3.8	3.7
Z159	0.83	1.07	0.48	1.07	1.08	2.4	2.1	1.8
Z160	5.81	5.73	2.11	5.81	7.52	4.3	5.0	4.4
Z161	0.96	1.29	0.32	1.29	1.35	3.2	2.9	2.7
Z162	1.94	2.92	0.91	2.92	2.99	2.4	2.0	3.0
Z163	1.89	2.47	0.34	2.47	3.11	2.6	2.6	2.3
Z164	1.92	5.67	0.56	5.67	5.94	2.6	4.0	4.9
Z165	3.57	2.17	1.76	3.57	3.86	2.5	2.4	3.9
Z166	1.92	2.21	1.18	2.21	2.21	2.8	2.8	5.9
Z167	1.40	1.57	0.68	1.57	2.07	2.3	3.0	4.1
Z168	1.12	1.10	0.47	1.12	1.16	3.6	2.6	2.7
Z169	1.10	0.99	0.30	1.10	1.12	2.6	3.6	2.7
Z170	0.91	1.02	0.39	1.02	1.20	2.6	2.9	2.6
Z171	0.67	2.46	0.47	2.46	2.46	2.2	2.4	4.0
Z172	2.24	0.99	0.38	2.24	2.41	2.3	2.7	2.2
Z173	1.01	1.52	0.40	1.52	1.61	2.1	3.0	3.4
Z174	5.20	1.37	1.45	5.20	5.25	2.1	2.3	3.9
Z175	1.06	0.99	0.35	1.06	1.22	2.8	2.1	2.3
Z176	0.89	1.73	0.39	1.73	1.73	2.4	2.5	3.8
Z177	2.71	1.48	0.64	2.71	2.85	2.5	2.4	5.0
Z178	2.81	1.27	1.03	2.81	2.82	3.0	3.0	3.0
Z179	0.91	1.87	0.35	1.87	1.90	3.0	3.1	5.4
Z180	5.38	13.87	3.60	13.87	13.96	2.7	2.4	8.4
Z181	1.55	0.85	0.50	1.55	1.77	2.0	1.3	3.1
Z182	1.60	2.16	0.57	2.16	2.27	2.8	2.3	3.8
Z183	3.40	2.45	0.84	3.40	4.21	2.7	3.5	3.8
Z184	1.06	2.40	0.66	2.40	2.43	1.7	5.2	3.9
Z185.1	2.78	3.20	1.21	3.20	3.76	3.1	2.5	3.1
Z185.2	3.18	2.43	0.93	3.18	3.61	3.3	2.9	3.1
Z186	1.40	2.09	0.51	2.09	2.16	2.0	2.0	2.9
Z187	1.94	2.24	0.33	2.24	2.88	3.8	4.0	2.5
Z188	1.22	0.46	0.40	1.22	1.29	2.9	1.4	3.0
Z189	1.04	1.18	0.42	1.18	1.54	2.9	2.7	3.2
Z190	1.05	0.78	0.21	1.05	1.30	3.7	1.6	3.4

Object	$v_{x,max}$ (mm/s)	$v_{y,max}$ (mm/s)	$v_{z,max}$ (mm/s)	$v_{x,y,max}$ (mm/s)	$\|v(t)\|_{max}$ (mm/s)	$f_{v,dom,x}$ (Hz)	$f_{v,dom,y}$ (Hz)	$f_{v,dom,z}$ (Hz)
Z191	2.25	4.04	0.58	4.04	4.63	2.5	3.0	3.9
Z192	1.03	0.96	0.31	1.03	1.10	3.4	2.5	2.0
Z193	0.67	1.06	0.31	1.06	1.25	2.4	2.2	4.2
Z194	1.20	0.45	0.22	1.20	1.28	0.7	0.0	3.6
Z195.1	0.73	2.12	0.78	2.12	2.16	3.4	2.6	3.6
Z195.2	0.61	1.95	0.57	1.95	1.98	3.4	2.6	3.6
Z196	1.05	1.14	0.50	1.14	1.48	2.4	1.8	4.2
Z197	1.30	1.25	0.58	1.30	1.76	2.6	2.8	5.4
Z198	1.25	0.62	0.26	1.25	1.27	2.6	4.4	2.2
Z199	1.98	3.11	0.99	3.11	3.12	2.9	3.4	6.6
Z200	2.18	1.35	0.65	2.18	2.50	2.8	2.0	3.7
Z201	3.05	4.08	0.61	4.08	4.29	1.7	2.2	3.4
Z202	4.23	2.48	0.56	4.23	4.47	2.9	2.4	2.4
Z203	2.40	3.50	1.01	3.50	3.65	2.3	2.3	5.8
Z204	1.38	0.64	0.21	1.38	1.49	2.4	2.6	2.7
Z205	0.36	2.03	0.48	2.03	2.03	1.4	1.3	3.6
Z206	1.12	1.72	0.33	1.72	1.95	3.3	2.5	2.3
Z211	0.59	1.19	0.23	1.19	1.32	1.4	2.9	2.8
Z212	13.18	5.73	5.30	13.18	13.18	2.3	1.7	9.2
Z213	0.67	2.45	0.47	2.45	2.46	2.2	2.4	3.3

*) An explanation of these values is given in Chapter 5

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z1	0.71	0.61	0.21	0.71
Z2	0.71	0.85	0.55	0.85
Z3	2.86	4.57	1.59	4.57
Z4	0.35	0.40	0.23	0.40
Z5	0.58	0.66	0.22	0.66
Z6	0.26	0.34	0.27	0.34
Z7	0.50	0.57	0.18	0.57
Z8	1.16	1.47	0.45	1.47
Z9	0.55	0.67	0.35	0.67
Z10	1.31	1.29	0.57	1.31
Z11	0.71	0.47	0.59	0.71
Z12	2.35	6.77	2.78	6.77
Z13	4.03	5.19	2.05	5.19
Z14	1.36	0.67	1.07	1.36
Z15	0.76	0.42	0.14	0.76
Z16	1.01	0.75	0.70	1.01
Z17	1.00	4.84	1.78	4.84
Z18	3.93	1.71	1.43	3.93
Z19	0.53	0.47	0.26	0.53
Z20	0.47	0.34	0.08	0.47
Z21	0.38	0.39	0.54	0.54
Z22	2.19	7.24	2.36	7.24
Z23	0.62	0.75	0.24	0.75
Z24	0.63	0.78	0.33	0.78
Z25	1.55	0.93	0.48	1.55
Z26	0.28	0.23	0.15	0.28
Z27	0.16	0.39	0.09	0.39
Z28	0.82	0.67	0.12	0.82
Z29	0.99	0.49	0.28	0.99
Z30	0.31	0.29	0.17	0.31
Z31	3.69	3.83	1.45	3.83
Z32	0.47	0.66	0.42	0.66
Z33	0.96	1.02	0.49	1.02
Z34	0.51	0.18	0.09	0.51
Z35	1.22	1.83	0.26	1.83
Z36	0.46	0.41	0.31	0.46
Z37	0.33	0.50	0.27	0.50
Z38	2.78	3.91	1.58	3.91

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z39	2.52	4.54	2.79	4.54
Z40	3.00	8.57	1.77	8.57
Z41	0.77	0.96	0.44	0.96
Z42	0.32	0.24	0.24	0.32
Z43	2.26	4.76	1.78	4.76
Z44	2.75	2.13	1.61	2.75
Z45	0.58	0.68	0.29	0.68
Z46	0.92	0.75	0.27	0.92
Z47	1.39	1.79	0.79	1.79
Z48	0.54	0.27	0.28	0.54
Z49	3.15	2.80	1.79	3.15
Z50	1.14	1.05	0.24	1.14
Z51	0.60	0.28	0.25	0.60
Z52	0.90	0.68	0.55	0.90
Z53	0.96	0.76	0.76	0.96
Z54	0.30	0.25	0.18	0.30
Z55	0.48	0.53	0.31	0.53
Z56	5.99	9.30	2.47	9.30
Z57	0.25	0.35	0.08	0.35
Z58	0.46	0.45	0.27	0.46
Z59	0.49	0.32	0.11	0.49
Z60	3.56	2.69	1.53	3.56
Z61	0.27	1.04	0.14	1.04
Z62	2.58	2.66	0.81	2.66
Z63	0.31	0.29	0.14	0.31
Z64	0.39	0.39	0.23	0.39
Z65	0.25	0.66	0.23	0.66
Z66	0.45	1.00	0.14	1.00
Z67	0.22	0.54	0.11	0.54
Z68	0.23	0.24	0.07	0.24
Z69	0.23	0.64	0.25	0.64
Z70	1.37	1.69	0.35	1.69
Z71	0.91	0.86	0.89	0.91
Z72	0.55	0.17	0.21	0.55
Z73	0.29	0.51	0.19	0.51
Z74	4.31	3.65	1.63	4.31
Z75	0.79	0.38	0.18	0.79
Z76	1.86	9.19	1.77	9.19
Z77	0.66	0.59	0.13	0.66

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z78	1.59	0.62	0.28	1.59
Z79	0.22	0.50	0.21	0.50
Z80	0.48	0.40	0.15	0.48
Z81	3.60	2.54	1.29	3.60
Z82	0.35	0.54	0.31	0.54
Z83	0.87	0.57	0.16	0.87
Z84	1.23	1.98	0.27	1.98
Z85	1.68	0.42	0.19	1.68
Z86	0.20	0.31	0.10	0.31
Z87	0.53	0.20	0.14	0.53
Z88	0.77	0.44	0.29	0.77
Z89	1.00	1.17	0.50	1.17
Z90	0.46	0.19	0.19	0.46
Z91	3.96	2.10	1.76	3.96
Z92	0.49	0.42	0.29	0.49
Z93	1.48	6.58	2.60	6.58
Z94	0.55	0.46	0.11	0.55
Z95	0.57	0.86	0.13	0.86
Z96	0.29	0.35	0.13	0.35
Z97	0.83	0.45	0.21	0.83
Z98	0.21	0.43	0.10	0.43
Z99	0.69	0.70	0.77	0.77
Z100	1.15	1.28	0.97	1.28
Z101	0.73	0.57	0.22	0.73
Z102	0.62	0.82	0.27	0.82
Z103	0.74	0.57	0.29	0.74
Z104	0.60	0.32	0.25	0.60
Z105	1.12	0.49	0.61	1.12
Z106	0.56	0.72	0.28	0.72
Z107	1.07	0.51	0.23	1.07
Z108	0.36	0.57	0.28	0.57
Z109	0.86	1.02	0.37	1.02
Z110	1.24	0.58	0.34	1.24
Z111	7.11	8.68	2.12	8.68
Z112	1.35	1.58	0.39	1.58
Z113	0.43	0.67	0.63	0.67
Z114	3.97	3.25	0.99	3.97
Z115	0.93	1.47	0.45	1.47
Z116	2.21	5.65	1.62	5.65

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z117	1.37	0.82	0.47	1.37
Z118	0.92	0.77	0.36	0.92
Z119	2.46	5.05	1.71	5.05
Z120	1.08	0.50	0.44	1.08
Z121	4.33	3.78	0.57	4.33
Z122	0.77	1.03	2.11	2.11
Z123	2.20	3.61	1.62	3.61
Z124	0.87	0.70	0.42	0.87
Z125	2.42	3.94	1.48	3.94
Z126	0.63	0.79	0.36	0.79
Z127	0.82	1.59	0.20	1.59
Z128	1.19	3.92	0.82	3.92
Z129	2.63	3.28	2.26	3.28
Z130	1.03	0.40	0.20	1.03
Z131	0.37	0.37	0.11	0.37
Z132	0.43	0.27	0.18	0.43
Z133	0.57	0.71	0.21	0.71
Z134	0.39	0.52	0.29	0.52
Z135	0.67	0.55	0.77	0.77
Z136	0.27	0.51	0.13	0.51
Z137	2.43	2.30	1.55	2.43
Z138	1.08	1.40	0.40	1.40
Z139	0.25	0.73	0.17	0.73
Z140	0.59	1.04	0.16	1.04
Z141	0.51	0.44	0.11	0.51
Z142	2.98	3.39	0.99	3.39
Z143	0.45	0.26	0.53	0.53
Z144	1.30	0.88	0.43	1.30
Z145	0.16	0.60	0.25	0.60
Z146	0.47	0.28	0.20	0.47
Z147	1.60	0.90	0.38	1.60
Z148	0.62	0.34	0.22	0.62
Z149	1.71	2.08	0.69	2.08
Z150	1.39	2.12	0.68	2.12
Z151	1.61	7.68	2.30	7.68
Z152	0.50	0.46	0.33	0.50
Z153	4.03	3.06	2.08	4.03
Z154	0.69	1.13	0.74	1.13
Z155	1.11	0.69	0.58	1.11

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z156	0.65	0.54	0.78	0.78
Z157	0.25	0.19	0.21	0.25
Z158	0.86	0.56	0.32	0.86
Z159	0.25	0.27	0.16	0.27
Z160	2.11	1.90	0.81	2.11
Z161	0.29	0.37	0.15	0.37
Z162	0.64	0.90	0.39	0.90
Z163	0.61	0.79	0.14	0.79
Z164	0.70	2.15	0.22	2.15
Z165	1.19	0.86	0.88	1.19
Z166	0.60	0.75	0.55	0.75
Z167	0.49	0.66	0.27	0.66
Z168	0.34	0.34	0.20	0.34
Z169	0.32	0.30	0.14	0.32
Z170	0.26	0.30	0.17	0.30
Z171	0.22	0.78	0.15	0.78
Z172	0.61	0.27	0.13	0.61
Z173	0.42	0.53	0.17	0.53
Z174	1.63	0.41	0.72	1.63
Z175	0.34	0.27	0.11	0.34
Z176	0.28	0.50	0.15	0.50
Z177	0.74	0.47	0.22	0.74
Z178	1.04	0.61	0.44	1.04
Z179	0.35	0.61	0.13	0.61
Z180	2.51	4.54	1.51	4.54
Z181	0.42	0.23	0.18	0.42
Z182	0.49	0.66	0.24	0.66
Z183	1.13	0.80	0.34	1.13
Z184	0.34	0.99	0.25	0.99
Z185.1	1.00	1.16	0.55	1.16
Z185.2	1.07	0.94	0.32	1.07
Z186	0.44	0.61	0.21	0.61
Z187	0.74	0.72	0.12	0.74
Z188	0.33	0.13	0.13	0.33
Z189	0.39	0.37	0.15	0.39
Z190	0.34	0.28	0.07	0.34
Z191	0.76	1.36	0.25	1.36
Z192	0.32	0.27	0.11	0.32
Z193	0.19	0.30	0.12	0.30

Object	$v_{eff,x,max}$ (mm/s)	$v_{eff,y,max}$ (mm/s)	$v_{eff,z,max}$ (mm/s)	$v_{eff,max}$ (mm/s)
Z194	0.28	0.08	0.08	0.28
Z195.1	0.23	0.68	0.31	0.68
Z195.2	0.20	0.62	0.21	0.62
Z196	0.30	0.35	0.18	0.35
Z197	0.49	0.46	0.21	0.49
Z198	0.38	0.28	0.09	0.38
Z199	0.65	1.16	0.48	1.16
Z200	0.62	0.41	0.24	0.62
Z201	0.84	1.12	0.25	1.12
Z202	1.50	0.95	0.24	1.50
Z203	1.12	1.05	0.45	1.12
Z204	0.41	0.19	0.09	0.41
Z205	0.15	0.56	0.19	0.56
Z206	0.43	0.59	0.13	0.59
Z211	0.17	0.35	0.08	0.35
Z212	4.72	2.17	2.80	4.72
Z213	0.22	0.78	0.15	0.78

F Vibration characteristics regarding Cumulative Absolute Velocity (CAV)

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z1	101.7	113.6	61.3	276.6	69.0	83.8	43.9	196.7
Z2	98.8	126.5	102.1	327.5	73.1	100.2	75.9	249.1
Z3	375.2	348.4	229.5	953.0	340.0	321.8	202.3	864.1
Z4	72.7	78.3	75.7	226.7	41.4	46.3	27.5	115.2
Z5	67.6	90.4	59.1	217.1	32.0	56.9	30.3	119.3
Z6	50.0	61.8	51.7	163.5	17.5	28.0	29.2	74.7
Z7	73.4	58.1	49.2	180.7	39.3	24.4	28.0	91.7
Z8	131.4	131.9	106.8	370.1	102.3	102.0	84.2	288.6
Z9	77.4	84.7	91.4	253.5	49.0	58.1	69.9	177.0
Z10	158.3	162.0	162.6	482.9	131.7	139.7	139.6	411.0
Z11	163.5	119.3	114.7	397.5	141.8	88.5	90.9	321.2
Z12	297.4	461.4	372.6	1131.4	279.9	435.7	355.6	1071.2
Z13	270.0	296.6	293.6	860.1	247.2	272.1	274.0	793.4
Z14	176.7	108.2	166.4	451.3	151.8	85.7	140.6	378.1
Z15	87.1	68.1	43.6	198.8	50.6	36.6	10.3	97.5
Z16	158.9	103.9	121.1	383.9	142.7	75.3	98.8	316.8
Z17	208.5	291.2	232.6	732.4	185.9	265.1	203.0	653.9
Z18	275.8	221.1	187.4	684.3	255.3	198.2	166.2	619.7
Z19	93.2	88.2	82.2	263.6	59.1	56.5	51.7	167.2
Z20	66.8	57.1	33.4	157.2	30.9	19.5	0.0	50.4
Z21	80.0	90.8	86.5	257.4	44.7	50.7	61.6	157.0
Z22	283.7	454.2	330.6	1068.5	262.1	427.8	311.5	1001.3
Z23	96.2	119.5	77.2	292.9	65.1	83.4	41.6	190.1
Z24	118.7	112.5	103.4	334.5	86.6	79.0	77.5	243.1
Z25	132.8	122.4	122.6	377.8	110.5	88.6	101.7	300.8
Z26	53.7	50.7	35.3	139.7	14.3	10.5	20.5	45.3
Z27	28.8	32.5	28.4	89.7	9.1	10.0	6.4	25.5
Z28	83.5	74.6	47.7	205.7	54.0	47.8	9.7	111.5
Z29	89.9	71.7	69.9	231.4	57.7	42.6	50.0	150.3
Z30	58.9	55.9	56.9	171.7	19.9	19.5	6.9	46.3
Z31	264.5	322.7	242.4	829.5	241.4	301.4	218.2	761.0
Z32	129.3	125.5	106.0	360.8	101.2	100.0	78.4	279.6
Z33	180.5	194.5	138.3	513.4	159.8	172.8	104.6	437.2
Z34	81.5	55.1	26.6	163.2	42.5	8.8	0.0	51.3

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z35	114.1	147.0	55.4	316.5	82.2	117.0	39.3	238.5
Z36	80.2	80.3	53.9	214.4	45.0	38.4	34.0	117.4
Z37	70.3	70.8	77.0	218.1	30.7	28.4	42.9	102.0
Z38	209.1	278.0	163.4	650.5	188.8	258.2	143.7	590.7
Z39	251.8	293.3	334.4	879.5	226.1	270.5	310.7	807.2
Z40	211.4	351.4	227.6	790.3	188.3	332.4	199.9	720.5
Z41	117.3	135.1	91.8	344.2	93.0	97.0	69.7	259.7
Z42	55.8	64.4	49.6	169.8	21.2	22.5	28.8	72.5
Z43	249.8	302.7	246.4	798.9	230.6	281.6	219.1	731.3
Z44	255.6	229.2	214.4	699.3	236.0	205.2	189.7	630.8
Z45	116.0	134.0	79.4	329.4	84.3	104.3	53.3	241.9
Z46	105.2	107.1	94.4	306.7	74.2	78.0	71.7	223.9
Z47	215.5	217.2	188.4	621.2	190.5	191.9	162.7	545.2
Z48	85.6	66.9	64.9	217.5	50.2	37.5	36.7	124.4
Z49	270.6	251.4	171.0	693.1	245.9	232.8	151.2	629.9
Z50	126.4	105.1	69.4	300.9	92.6	75.3	40.6	208.5
Z51	67.5	57.5	76.7	201.7	35.0	21.7	48.4	105.1
Z52	113.0	120.9	98.0	332.0	88.7	92.3	73.9	254.9
Z53	169.0	134.3	143.4	446.8	141.9	109.1	122.6	373.5
Z54	48.1	42.8	42.0	132.9	12.0	10.2	17.3	39.5
Z55	99.4	126.6	81.2	307.2	53.9	92.9	48.0	194.8
Z56	379.6	492.1	293.1	1164.8	353.4	455.1	260.4	1068.9
Z57	39.9	42.4	29.8	112.1	15.7	17.8	11.0	44.4
Z58	60.8	52.2	55.7	168.7	9.8	22.6	35.2	67.6
Z59	66.7	66.1	30.0	162.8	29.5	28.2	9.7	67.4
Z60	316.7	262.4	192.1	771.2	289.0	233.7	169.7	692.5
Z61	65.7	88.1	50.9	204.7	33.8	60.4	30.9	125.1
Z62	173.8	193.1	132.1	499.0	146.1	167.1	103.7	416.8
Z63	53.3	51.0	33.7	137.9	20.9	19.7	11.2	51.8
Z64	54.0	58.0	58.7	170.7	19.1	26.2	34.2	79.6
Z65	55.2	69.6	54.9	179.6	18.5	25.9	31.7	76.2
Z66	72.3	103.5	39.6	215.4	37.3	74.8	16.1	128.2
Z67	50.1	59.9	27.9	138.0	18.5	24.0	7.0	49.5
Z68	56.8	50.4	21.9	129.1	18.9	15.8	0.0	34.7
Z69	64.9	97.5	61.1	223.6	31.5	63.7	40.3	135.6
Z70	222.3	217.1	70.7	510.0	199.3	190.7	47.2	437.2
Z71	122.6	100.6	116.9	340.1	93.8	65.8	93.9	253.5
Z72	67.9	57.0	80.2	205.0	34.8	15.3	21.6	71.7
Z73	69.2	88.9	53.9	211.9	41.4	54.3	35.7	131.5

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z74	348.0	422.6	245.0	1015.7	315.0	383.6	213.4	912.0
Z75	83.5	72.9	49.3	205.7	45.4	35.7	21.1	102.3
Z76	196.6	367.0	227.4	791.0	172.3	337.8	197.0	707.1
Z77	102.5	89.7	50.4	242.6	65.9	50.0	24.4	140.4
Z78	118.7	81.5	62.6	262.8	88.9	47.8	41.1	177.8
Z79	53.8	59.6	49.3	162.7	14.1	21.7	26.7	62.5
Z80	83.5	68.3	50.5	202.3	49.4	28.3	25.2	102.8
Z81	283.0	310.2	238.1	831.4	256.5	289.6	218.4	764.5
Z82	75.6	81.2	90.3	247.1	26.2	50.6	52.6	129.3
Z83	106.9	94.7	47.8	249.5	73.5	67.7	22.3	163.6
Z84	112.5	150.0	58.4	321.0	83.2	126.5	41.5	251.2
Z85	127.5	83.2	68.1	278.7	102.2	57.7	44.9	204.7
Z86	48.7	61.2	37.0	147.0	13.0	26.9	7.7	47.5
Z87	58.9	46.1	38.0	143.1	20.9	10.4	13.4	44.7
Z88	144.0	122.9	89.5	356.4	107.9	94.2	56.7	258.8
Z89	184.0	171.2	150.1	505.3	148.4	133.9	110.5	392.8
Z90	59.5	54.2	54.5	168.1	23.0	9.3	32.4	64.7
Z91	268.8	191.5	183.7	644.0	247.2	166.1	163.2	576.5
Z92	87.4	78.6	86.2	252.1	53.6	50.1	55.7	159.4
Z93	219.8	312.0	261.2	793.1	191.9	290.8	237.9	720.6
Z94	83.3	73.0	37.0	193.2	47.3	36.0	6.4	89.8
Z95	98.9	94.1	44.2	237.2	68.5	69.5	19.4	157.3
Z96	51.0	48.8	36.4	136.2	10.3	21.9	7.1	39.3
Z97	71.1	73.0	55.9	200.0	41.7	45.1	32.9	119.7
Z98	48.6	68.8	28.4	145.9	19.4	39.3	0.0	58.7
Z99	158.7	114.3	135.4	408.4	136.5	84.2	112.8	333.5
Z100	171.8	174.2	167.7	513.7	150.0	144.4	145.4	439.8
Z101	100.3	90.9	91.3	282.5	64.9	60.9	60.2	186.0
Z102	103.8	95.8	73.9	273.5	69.9	68.9	55.3	194.0
Z103	135.7	123.6	85.2	344.5	110.3	101.0	60.9	272.2
Z104	66.4	64.0	62.5	192.9	25.8	26.9	39.6	92.3
Z105	149.9	121.4	140.5	411.8	124.4	94.6	116.9	335.9
Z106	79.3	87.1	75.9	242.3	41.7	57.2	50.5	149.4
Z107	158.4	111.0	75.9	345.3	135.1	84.0	58.2	277.3
Z108	73.8	84.0	72.6	230.4	34.1	46.7	50.1	130.9
Z109	107.9	125.0	90.6	323.4	79.6	95.1	56.8	231.5
Z110	139.7	122.2	111.7	373.6	109.5	94.0	82.4	285.9
Z111	487.3	513.1	376.6	1376.9	463.0	492.1	358.4	1313.5
Z112	181.7	190.7	115.6	488.0	155.0	156.9	85.9	397.8

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z113	91.6	126.7	120.8	339.1	61.4	95.8	99.9	257.2
Z114	240.0	282.4	205.9	728.3	210.4	248.0	173.0	631.4
Z115	166.0	167.4	87.6	420.9	144.8	129.0	65.6	339.3
Z116	279.6	406.5	307.6	993.7	221.0	354.4	161.3	736.6
Z117	128.3	105.5	116.1	350.0	99.7	70.3	91.5	261.5
Z118	110.4	139.7	87.1	337.2	84.7	114.5	60.6	259.8
Z119	298.0	363.3	303.5	964.8	251.4	318.8	243.8	813.9
Z120	112.6	104.2	100.6	317.4	78.3	71.7	79.2	229.2
Z121	278.4	334.1	134.3	746.8	255.7	304.8	104.8	665.3
Z122	125.6	130.3	247.1	503.0	97.4	96.7	222.8	416.9
Z123	228.9	267.4	173.0	669.3	211.4	245.7	152.4	609.5
Z124	155.2	144.7	128.8	428.7	129.0	114.8	101.0	344.8
Z125	280.4	287.8	242.3	810.4	258.8	265.1	217.2	741.1
Z126	82.5	109.3	91.0	282.9	45.9	73.9	73.5	193.3
Z127	90.0	111.7	59.6	261.2	55.1	81.2	35.6	171.9
Z128	156.9	254.7	115.2	526.7	127.9	226.6	86.0	440.6
Z129	221.6	262.5	268.8	752.9	197.8	239.0	243.6	680.4
Z130	121.0	78.0	53.2	252.1	81.2	46.5	35.1	162.7
Z131	75.6	70.3	39.1	185.0	46.6	39.1	7.4	93.1
Z132	60.6	55.1	46.9	162.6	21.6	21.6	19.6	62.8
Z133	77.7	83.6	46.9	208.2	47.3	54.1	24.1	125.5
Z134	70.6	84.9	56.0	211.5	30.4	42.8	32.6	105.8
Z135	100.6	94.6	142.7	337.9	72.6	68.0	111.5	252.2
Z136	59.4	76.4	53.9	189.6	23.2	49.4	18.2	90.8
Z137	203.7	223.9	215.7	643.3	180.0	194.4	194.6	568.9
Z138	112.1	122.1	82.5	316.7	74.6	96.8	52.3	223.7
Z139	68.4	93.2	52.0	213.6	32.7	59.1	22.9	114.6
Z140	82.8	103.4	48.7	234.9	51.6	82.4	21.3	155.4
Z141	80.1	70.8	39.8	190.8	48.9	39.4	3.7	92.0
Z142	230.8	338.9	215.2	785.0	200.0	235.2	184.3	619.5
Z143	83.9	70.2	98.6	252.7	57.1	38.1	74.5	169.7
Z144	151.2	127.5	89.0	367.7	127.0	98.5	66.7	292.2
Z145	47.5	60.4	48.7	156.7	5.6	24.9	27.5	58.0
Z146	59.1	57.1	50.2	166.3	15.6	13.4	26.4	55.3
Z147	119.9	105.7	93.6	319.3	80.7	72.2	65.7	218.7
Z148	71.6	78.5	53.9	204.0	35.7	48.0	31.9	115.5
Z149	142.8	156.9	137.4	437.1	112.1	125.6	110.1	347.8
Z150	135.7	207.2	143.0	485.9	110.0	179.7	122.7	412.4
Z151	203.4	323.7	260.5	787.6	185.7	295.3	230.2	711.2

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z152	120.0	97.3	72.6	289.9	92.8	65.7	53.5	212.0
Z153	319.9	351.8	284.9	956.6	300.5	330.7	261.2	892.4
Z154	137.1	211.5	159.1	507.6	90.3	168.7	117.8	376.9
Z155	138.1	145.4	93.8	377.3	106.0	127.0	76.9	309.8
Z156	120.2	97.4	125.6	343.2	86.0	57.0	101.1	244.2
Z157	52.8	86.5	97.8	237.1	8.1	25.5	44.3	77.8
Z158	106.5	100.4	63.9	270.8	79.1	69.7	45.1	193.9
Z159	49.8	46.4	30.2	126.4	9.5	13.0	11.4	33.9
Z160	208.1	227.6	224.3	660.0	187.7	200.9	201.4	589.9
Z161	59.2	58.6	45.5	163.3	35.3	29.9	11.4	76.6
Z162	139.0	120.3	121.9	381.2	100.0	83.6	71.1	254.7
Z163	78.6	77.6	51.5	207.6	45.8	48.6	27.1	121.5
Z164	96.4	135.9	51.9	284.1	68.5	104.2	36.4	209.0
Z165	139.9	128.8	172.6	441.3	104.7	83.8	138.6	327.0
Z166	110.1	142.6	124.5	377.1	68.7	109.4	97.5	275.6
Z167	87.7	100.9	73.0	261.5	61.0	68.6	46.9	176.5
Z168	63.7	75.8	62.6	202.1	30.8	42.1	32.5	105.4
Z169	66.0	61.2	47.4	174.6	33.0	28.1	17.1	78.2
Z170	60.9	63.0	52.1	176.1	34.3	32.7	28.3	95.4
Z171	57.9	102.0	37.0	196.9	25.0	69.2	6.2	100.3
Z172	90.0	74.0	54.7	218.7	53.6	30.1	13.5	97.2
Z173	66.6	68.4	44.3	179.3	38.3	42.7	21.5	102.6
Z174	135.8	104.3	124.0	364.1	111.7	65.2	98.2	275.0
Z175	66.3	63.4	53.2	182.9	25.6	24.1	0.0	49.7
Z176	65.1	72.2	48.9	186.3	26.2	30.0	9.4	65.6
Z177	89.2	69.1	67.1	225.3	56.4	38.7	42.5	137.6
Z178	123.2	130.7	97.4	351.2	95.1	103.0	69.8	267.9
Z179	83.3	130.2	141.7	355.2	18.4	46.6	9.1	74.1
Z180	232.8	258.9	206.3	698.1	210.0	233.9	178.9	622.8
Z181	55.1	44.4	39.8	139.3	21.6	4.9	14.2	40.7
Z182	73.9	83.5	71.6	229.1	42.9	52.9	43.1	138.9
Z183	104.5	89.4	98.6	292.4	66.8	40.6	54.6	162.1
Z184	99.7	138.2	100.8	338.6	39.7	91.7	44.0	175.5
Z185.1	157.0	137.3	117.1	411.3	117.1	105.6	89.0	311.8
Z185.2	126.8	157.6	105.2	389.6	101.4	125.7	77.3	304.4
Z186	82.1	102.5	57.5	242.1	47.1	64.9	34.4	146.4
Z187	80.7	87.1	84.5	252.3	47.3	57.2	18.6	123.1
Z188	44.1	42.1	45.7	131.9	8.8	5.2	16.6	30.6
Z189	65.3	73.2	53.4	191.9	36.8	41.7	4.6	83.1

Object	cav_x (mm/s)	cav_y (mm/s)	cav_z (mm/s)	cav_{total} (mm/s)	$cav_{std,x}$ (mm/s)	$cav_{std,y}$ (mm/s)	$cav_{std,z}$ (mm/s)	$cav_{std,total}$ (mm/s)
Z190	47.2	55.7	31.1	134.0	16.9	22.4	0.0	39.3
Z191	84.8	111.1	83.8	279.7	54.9	78.0	49.5	182.3
Z192	87.1	65.9	65.3	218.3	38.8	19.9	29.1	87.8
Z193	44.1	60.0	35.3	139.5	8.2	22.2	2.1	32.6
Z194	803.2	80.4	28.8	912.3	772.9	0.0	0.0	772.9
Z195.1	71.2	98.1	69.6	238.9	43.0	66.8	54.9	164.7
Z195.2	60.6	84.8	53.8	199.2	29.1	51.2	36.5	116.9
Z196	67.8	65.3	53.5	186.7	31.7	31.5	16.9	80.1
Z197	77.0	92.0	49.3	218.3	48.7	51.2	16.3	116.2
Z198	71.0	56.2	30.0	157.1	40.5	29.3	4.9	74.7
Z199	117.7	126.6	105.1	349.4	77.0	75.0	67.1	219.1
Z200	83.8	77.7	56.0	217.6	56.1	43.7	30.0	129.7
Z201	140.3	140.2	71.5	352.0	97.5	95.6	49.1	242.2
Z202	149.5	152.0	77.5	379.0	126.0	120.2	57.0	303.2
Z203	140.0	156.8	128.6	425.3	105.8	107.6	98.0	311.4
Z204	48.5	42.5	31.3	122.4	18.0	4.1	12.3	34.5
Z205	46.5	82.8	46.4	175.7	14.0	49.5	21.0	84.5
Z206	67.6	77.2	39.7	184.4	36.3	41.4	3.5	81.3
Z211	46.4	53.5	42.7	142.6	9.3	9.9	8.4	27.6
Z212	329.2	273.9	321.5	924.6	286.3	228.9	268.2	783.4
Z213	74.9	118.0	45.5	238.4	25.2	68.5	6.2	99.8

G Vibration characteristics Arias Intensity (I_A)

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z1	0.18	0.20	0.07	0.44
Z2	0.18	0.30	0.28	0.76
Z3	4.00	4.45	2.33	10.78
Z4	0.07	0.11	0.05	0.23
Z5	0.07	0.13	0.06	0.25
Z6	0.04	0.05	0.05	0.14
Z7	0.09	0.06	0.05	0.20
Z8	0.37	0.45	0.36	1.19
Z9	0.10	0.14	0.17	0.41
Z10	0.79	0.80	0.71	2.29
Z11	0.49	0.20	0.34	1.03
Z12	2.30	10.47	6.12	18.88
Z13	3.74	5.59	4.42	13.76
Z14	0.73	0.22	0.90	1.85
Z15	0.14	0.07	0.02	0.23
Z16	0.56	0.19	0.44	1.18
Z17	0.76	3.62	1.42	5.79
Z18	2.52	1.16	1.66	5.34
Z19	0.12	0.10	0.14	0.36
Z20	0.07	0.04	0.01	0.12
Z21	0.09	0.12	0.19	0.39
Z22	2.09	9.07	4.58	15.75
Z23	0.14	0.23	0.09	0.47
Z24	0.23	0.20	0.18	0.62
Z25	0.51	0.28	0.45	1.24
Z26	0.04	0.03	0.03	0.10
Z27	0.02	0.02	0.01	0.05
Z28	0.15	0.13	0.02	0.30
Z29	0.20	0.09	0.11	0.39
Z30	0.04	0.04	0.03	0.10
Z31	2.25	4.28	2.19	8.72
Z32	0.21	0.24	0.34	0.80
Z33	0.57	0.59	0.35	1.50
Z34	0.11	0.03	0.01	0.15
Z35	0.31	0.54	0.06	0.91

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z36	0.10	0.08	0.07	0.25
Z37	0.06	0.05	0.09	0.20
Z38	1.32	3.57	1.52	6.41
Z39	2.27	4.02	5.58	11.86
Z40	1.15	7.15	2.74	11.04
Z41	0.29	0.34	0.15	0.78
Z42	0.04	0.05	0.05	0.15
Z43	2.22	4.76	2.61	9.59
Z44	2.33	1.41	1.88	5.62
Z45	0.23	0.26	0.09	0.58
Z46	0.23	0.23	0.16	0.62
Z47	0.93	1.05	0.78	2.76
Z48	0.13	0.06	0.06	0.25
Z49	2.21	1.77	1.92	5.90
Z50	0.32	0.21	0.09	0.62
Z51	0.07	0.04	0.06	0.18
Z52	0.26	0.27	0.34	0.87
Z53	0.51	0.32	0.54	1.37
Z54	0.03	0.03	0.03	0.08
Z55	0.13	0.20	0.15	0.48
Z56	6.71	17.51	5.65	29.88
Z57	0.03	0.03	0.02	0.08
Z58	0.05	0.05	0.07	0.17
Z59	0.06	0.06	0.01	0.14
Z60	3.35	1.89	1.68	6.93
Z61	0.06	0.19	0.04	0.28
Z62	1.09	1.23	0.58	2.89
Z63	0.04	0.04	0.02	0.10
Z64	0.05	0.05	0.06	0.16
Z65	0.04	0.09	0.06	0.19
Z66	0.08	0.23	0.02	0.34
Z67	0.03	0.06	0.01	0.11
Z68	0.04	0.03	0.01	0.08
Z69	0.05	0.16	0.05	0.27
Z70	1.04	1.05	0.08	2.17
Z71	0.28	0.21	0.49	0.98
Z72	0.07	0.02	0.04	0.13
Z73	0.06	0.11	0.06	0.24
Z74	4.73	4.85	2.01	11.59

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z75	0.14	0.08	0.03	0.24
Z76	0.84	8.29	2.56	11.69
Z77	0.17	0.14	0.04	0.34
Z78	0.41	0.12	0.08	0.60
Z79	0.03	0.05	0.05	0.13
Z80	0.10	0.07	0.04	0.20
Z81	2.78	2.90	1.81	7.49
Z82	0.06	0.10	0.11	0.27
Z83	0.21	0.15	0.04	0.40
Z84	0.31	0.63	0.08	1.03
Z85	0.42	0.11	0.08	0.61
Z86	0.03	0.04	0.02	0.09
Z87	0.05	0.02	0.02	0.10
Z88	0.35	0.21	0.14	0.71
Z89	0.56	0.50	0.37	1.43
Z90	0.05	0.03	0.05	0.13
Z91	2.53	0.95	2.20	5.68
Z92	0.12	0.10	0.11	0.33
Z93	1.01	4.94	3.78	9.73
Z94	0.11	0.08	0.02	0.21
Z95	0.16	0.19	0.03	0.38
Z96	0.04	0.04	0.02	0.10
Z97	0.11	0.08	0.06	0.26
Z98	0.03	0.07	0.01	0.11
Z99	0.48	0.22	0.57	1.27
Z100	0.58	0.66	1.03	2.27
Z101	0.18	0.13	0.14	0.45
Z102	0.22	0.19	0.10	0.51
Z103	0.35	0.22	0.11	0.68
Z104	0.07	0.05	0.09	0.21
Z105	0.43	0.22	0.57	1.22
Z106	0.12	0.14	0.10	0.36
Z107	0.47	0.21	0.08	0.76
Z108	0.07	0.11	0.10	0.28
Z109	0.22	0.28	0.13	0.63
Z110	0.37	0.26	0.21	0.84
Z111	10.80	19.17	5.53	35.50
Z112	0.61	0.71	0.22	1.54
Z113	0.11	0.24	0.35	0.70

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z114	2.16	2.14	1.21	5.51
Z115	0.56	0.77	0.31	1.64
Z116	1.63	5.74	1.82	9.20
Z117	0.42	0.23	0.34	0.99
Z118	0.23	0.37	0.14	0.74
Z119	2.27	4.93	3.50	10.70
Z120	0.26	0.17	0.34	0.77
Z121	3.50	3.43	0.42	7.35
Z122	0.25	0.28	3.01	3.54
Z123	1.34	2.52	1.66	5.51
Z124	0.43	0.33	0.39	1.15
Z125	2.74	2.81	2.33	7.89
Z126	0.12	0.22	0.15	0.49
Z127	0.14	0.35	0.07	0.56
Z128	0.42	2.36	0.60	3.39
Z129	1.46	2.15	3.02	6.63
Z130	0.27	0.08	0.06	0.40
Z131	0.09	0.06	0.02	0.17
Z132	0.06	0.04	0.03	0.13
Z133	0.09	0.11	0.04	0.25
Z134	0.06	0.10	0.07	0.23
Z135	0.16	0.14	0.59	0.89
Z136	0.05	0.10	0.04	0.19
Z137	1.36	1.29	1.69	4.33
Z138	0.25	0.37	0.10	0.73
Z139	0.06	0.16	0.03	0.25
Z140	0.11	0.21	0.04	0.36
Z141	0.10	0.07	0.02	0.19
Z142	1.62	2.19	1.71	5.52
Z143	0.11	0.06	0.22	0.39
Z144	0.45	0.33	0.28	1.06
Z145	0.02	0.06	0.06	0.15
Z146	0.05	0.03	0.04	0.12
Z147	0.41	0.22	0.13	0.76
Z148	0.08	0.08	0.06	0.22
Z149	0.53	0.67	0.64	1.85
Z150	0.42	0.98	0.62	2.01
Z151	0.83	5.74	3.17	9.74
Z152	0.21	0.14	0.08	0.44

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z153	3.44	4.04	3.63	11.11
Z154	0.24	0.87	0.62	1.73
Z155	0.45	0.32	0.19	0.96
Z156	0.25	0.14	0.54	0.92
Z157	0.03	0.06	0.10	0.18
Z158	0.22	0.19	0.07	0.48
Z159	0.03	0.03	0.02	0.08
Z160	1.06	1.06	1.08	3.19
Z161	0.06	0.05	0.03	0.14
Z162	0.28	0.21	0.18	0.67
Z163	0.11	0.13	0.04	0.27
Z164	0.16	0.60	0.06	0.81
Z165	0.39	0.30	0.66	1.36
Z166	0.19	0.28	0.41	0.87
Z167	0.13	0.20	0.10	0.43
Z168	0.06	0.08	0.05	0.20
Z169	0.06	0.05	0.03	0.15
Z170	0.05	0.05	0.04	0.14
Z171	0.04	0.19	0.02	0.25
Z172	0.12	0.05	0.03	0.20
Z173	0.07	0.08	0.03	0.18
Z174	0.44	0.14	0.49	1.08
Z175	0.05	0.04	0.02	0.11
Z176	0.05	0.08	0.02	0.15
Z177	0.13	0.07	0.08	0.29
Z178	0.27	0.24	0.20	0.71
Z179	0.05	0.11	0.08	0.25
Z180	1.70	3.22	1.92	6.84
Z181	0.05	0.02	0.03	0.10
Z182	0.08	0.10	0.09	0.27
Z183	0.22	0.12	0.10	0.45
Z184	0.09	0.27	0.10	0.46
Z185.1	0.42	0.32	0.21	0.95
Z185.2	0.32	0.48	0.17	0.98
Z186	0.10	0.15	0.07	0.32
Z187	0.12	0.14	0.04	0.30
Z188	0.03	0.02	0.03	0.07
Z189	0.07	0.08	0.02	0.17
Z190	0.04	0.04	0.01	0.09

Object	I_{AX} (mm/s)	I_{AY} (mm/s)	I_{AZ} (mm/s)	$I_{A.TOTAL}$ (mm/s)
Z191	0.14	0.28	0.09	0.50
Z192	0.07	0.04	0.04	0.15
Z193	0.03	0.05	0.01	0.09
Z194	2.13	0.03	0.00	2.16
Z195.1	0.07	0.17	0.14	0.38
Z195.2	0.05	0.13	0.08	0.25
Z196	0.06	0.07	0.03	0.16
Z197	0.10	0.10	0.03	0.23
Z198	0.08	0.05	0.01	0.14
Z199	0.19	0.35	0.16	0.70
Z200	0.12	0.08	0.05	0.25
Z201	0.26	0.32	0.11	0.69
Z202	0.60	0.47	0.12	1.18
Z203	0.41	0.34	0.28	1.04
Z204	0.04	0.02	0.01	0.07
Z205	0.03	0.13	0.03	0.19
Z206	0.07	0.10	0.02	0.19
Z211	0.02	0.03	0.01	0.06
Z212	4.57	1.77	4.57	10.92
Z213	0.04	0.19	0.02	0.25

H Registration form for repetitive damage survey

Tabel voor herhalingsopname n.a.v. aardbeving

Id - Postcode	
Naam	
Adres	
Woonplaats	

Volgnummer herhalingsopname				
Datum herhalingsopname				
Aardbeving	Locatie en datum	Vmax		mm/s
	Locatie en datum	Vmax		mm/s
	Locatie en datum	Vmax		mm/s

Gevel	Scheurnr.	Locatie	Scheurwijdte A=<1mm; B=1-10mm; C=>10mm	Foto scheur	W(ijder) / L(anger) / H(ersteld) / O(nveranderd)	Nieuwe scheurwijdte	Foto scheur
Bestaande scheuren							
Nieuwe scheuren							
Opmerkingen							

I Results repetitive damage survey

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z1	1	0	0	1	0	0	0	1	0	0	0
Z2	19	8	0	14	0	0	5	3	1	0	0
Z3	28	0	0	16	0	0	1	2	0	0	0
Z5	26	38	1	13	0	0	5	0	2	0	0
Z7	0	0	0	0	0	0	5	0	0	0	0
Z8	10	2	0	6	0	0	0	0	0	0	0
Z9	11	4	1	10	0	0	10	0	0	0	0
Z10	6	1	0	1	0	0	10	0	0	0	0
Z11	25	13	0	0	1	0	0	0	0	0	0
Z12	21	2	0	0	0	0	1	0	0	0	0
Z13	2	2	0	0	0	0	7	0	0	0	0
Z14	2	0	0	0	0	0	3	0	0	0	0
Z15	16	0	0	14	0	0	2	0	0	0	0
Z16	3	0	0	0	0	0	1	0	0	0	0
Z17	7	6	1	5	1	0	30	2	1	0	0
Z18	8	0	0	0	0	0	0	0	0	0	0
Z19	6	0	0	0	0	0	0	0	0	0	0
Z20	0	0	0	0	0	0	0	0	0	0	0
Z21	5	5	0	0	0	0	3	0	0	0	0
Z22	29	0	0	3	0	0	0	0	0	0	0
Z23	8	9	0	11	0	0	4	2	0	0	0
Z24	12	3	0	0	0	0	0	0	0	0	0
Z25	4	1	0	5	0	0	7	0	0	0	0
Z26	7	0	0	1	0	0	1	0	0	0	0
Z27	9	1	0	0	0	0	0	0	0	0	0
Z28	9	0	0	6	0	0	9	0	0	0	0
Z29	2	0	0	2	0	0	1	0	0	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z30	9	1	0	0	0	0	7	0	3	0	0
Z31	8	1	0	2	0	0	2	0	0	0	0
Z32	8	11	0	0	0	0	0	0	0	0	0
Z33	2	4	0	5	0	0	12	2	0	0	0
Z34	4	1	0	0	0	0	2	0	0	0	0
Z35	0	0	0	0	0	0	1	0	0	0	0
Z36	2	0	0	2	0	0	12	0	0	0	0
Z37	6	0	0	6	0	0	1	0	0	0	0
Z38	11	0	0	0	0	0	0	0	0	0	0
Z39	1	1	0	0	1	0	1	0	0	0	0
Z40	13	0	0	7	0	0	11	1	2	0	0
Z41	4	0	0	0	0	0	5	0	0	0	0
Z42	8	4	0	1	1	1	2	1	0	0	0
Z43	1	0	0	0	1	0	3	0	0	0	0
Z44	5	0	0	0	5	0	10	0	0	0	0
Z45	11	2	0	1	0	0	1	0	0	0	0
Z47	0	0	0	0	0	0	3	0	0	0	0
Z48	17	9	1	0	1	0	15	0	0	0	0
Z49	6	1	0	0	0	0	2	0	0	0	0
Z50	3	0	0	0	0	0	6	0	0	0	0
Z51	13	9	0	18	0	0	13	1	0	0	0
Z52	6	0	0	0	0	0	5	0	0	0	0
Z53	14	0	0	3	3	0	3	1	0	0	0
Z54	0	0	0	0	0	0	2	0	0	0	0
Z55	1	23	1	0	0	0	1	0	0	0	0
Z56	29	9	0	29	0	0	0	0	0	0	0
Z57	14	0	0	0	0	0	0	0	0	0	0
Z58	11	0	0	1	0	0	1	0	0	0	0
Z59	3	0	0	1	0	0	9	1	0	0	0
Z60	2	0	0	0	0	0	0	0	0	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z61	14	1	0	8	0	0	0	0	0	0	0
Z62	11	2	0	0	0	0	1	0	0	0	0
Z63	0	0	0	0	0	0	0	0	0	0	0
Z64	10	6	0	14	0	0	5	7	1	0	0
Z65	4	0	0	0	0	0	1	0	0	0	0
Z66	12	2	0	0	0	0	0	0	0	0	0
Z67	4	0	0	0	0	0	0	0	0	0	0
Z68	10	0	0	5	0	0	4	1	0	0	0
Z69	13	0	0	9	0	0	2	0	0	0	0
Z70	3	1	0	1	0	0	0	0	0	0	0
Z71	2	0	0	0	0	0	0	0	0	0	0
Z72	0	3	0	0	0	0	0	0	1	0	0
Z73	16	0	0	10	0	0	0	2	0	0	0
Z74	9	0	0	0	1	0	16	0	1	0	0
Z75	1	0	0	0	0	0	0	0	0	0	0
Z76	6	1	0	0	0	0	0	0	0	0	0
Z77	10	0	0	2	0	0	0	0	0	0	0
Z78	14	1	0	0	2	0	2	0	0	0	0
Z79	28	1	0	5	10	0	3	1	0	0	0
Z80	3	0	0	0	0	0	0	0	0	0	0
Z81	10	0	0	10	0	0	3	0	0	0	0
Z82	10	0	0	2	0	0	2	0	0	0	0
Z83	7	0	0	0	0	0	0	0	0	0	0
Z84	3	0	0	0	0	0	4	0	0	0	0
Z85	9	2	0	0	0	0	12	0	0	0	0
Z86	4	0	0	0	0	0	7	0	0	0	0
Z87	9	0	0	8	0	0	0	0	0	0	0
Z88	10	5	0	0	0	0	14	0	1	0	0
Z89	18	1	0	1	0	0	26	1	1	0	0
Z90	2	0	0	0	0	0	0	0	1	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z91	2	0	0	1	0	0	0	0	0	0	0
Z92	12	2	0	0	1	0	1	0	0	0	0
Z93	12	2	0	8	0	0	1	3	0	0	0
Z94	5	0	0	4	0	0	0	0	0	0	0
Z95	21	0	0	0	0	0	7	0	0	0	0
Z96	16	5	0	12	0	0	6	3	0	0	0
Z97	3	1	0	0	0	0	17	0	1	0	0
Z98	6	0	0	0	0	0	4	0	0	0	0
Z99	5	0	0	0	0	0	0	0	1	0	0
Z100	6	1	0	3	0	0	2	0	0	0	0
Z101	25	0	0	0	0	0	10	0	1	0	0
Z102	3	0	0	0	1	0	5	0	0	0	0
Z103	7	1	0	0	0	0	0	0	0	0	0
Z104	0	1	0	1	0	0	15	0	0	0	0
Z105	13	0	0	8	0	0	0	0	0	0	0
Z106	2	1	0	0	0	0	5	0	0	0	0
Z107	2	0	0	0	0	0	0	0	0	0	0
Z108	10	14	0	0	2	0	4	0	2	0	0
Z109	6	0	0	0	0	0	9	0	0	0	0
Z110	2	0	0	0	0	0	0	0	0	0	0
Z111	16	1	0	16	0	0	2	0	0	0	0
Z112	2	0	0	0	0	0	1	0	0	0	0
Z113	16	3	0	6	0	0	1	0	0	0	0
Z114	4	3	0	2	0	0	7	0	0	0	0
Z115	3	0	0	0	0	0	8	0	1	0	0
Z116	7	0	0	0	0	0	0	0	0	0	0
Z117	0	0	0	0	0	0	2	0	0	0	0
Z118	0	0	0	0	0	0	2	0	0	0	0
Z119	21	3	0	4	0	0	0	1	0	0	0
Z120	4	0	0	0	0	0	2	0	0	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z121	3	0	0	3	0	0	0	1	0	0	0
Z122	3	1	0	0	0	0	10	0	0	0	0
Z123	5	1	0	1	0	0	2	0	0	0	0
Z124	17	0	0	0	0	0	0	0	0	0	0
Z125	2	0	0	0	0	0	7	0	0	0	0
Z126	33	8	0	1	0	0	0	0	0	0	0
Z127	5	0	0	3	0	0	6	0	0	0	0
Z128	6	0	0	1	1	0	5	0	0	0	0
Z129	19	1	0	2	0	0	6	0	0	0	0
Z130	13	0	0	5	0	0	2	0	0	0	0
Z131	5	0	0	0	0	0	0	0	0	0	0
Z132	2	0	0	1	0	0	2	0	0	0	0
Z133	4	0	0	0	0	0	1	0	0	0	0
Z134	3	0	0	0	0	0	3	0	0	0	0
Z135	0	0	0	0	0	0	1	0	0	0	0
Z136	7	0	0	4	0	0	7	0	0	0	0
Z137	12	1	0	1	0	0	6	0	1	0	0
Z138	10	0	0	0	0	0	4	0	0	0	0
Z139	13	2	0	8	0	0	0	0	0	0	0
Z140	9	0	0	6	0	0	0	0	0	0	0
Z141	14	1	0	11	0	0	1	0	0	0	0
Z142	4	1	0	0	0	0	8	0	0	0	0
Z143	0	8	0	3	0	0	11	0	1	0	0
Z144	0	0	0	0	0	0	0	0	0	0	0
Z145	6	25	2	32	0	0	0	0	0	1	0
Z146	1	0	0	0	0	0	4	0	0	0	0
Z147	1	1	0	1	1	0	0	0	0	0	0
Z148	6	0	0	0	0	0	2	0	0	0	0
Z149	7	2	0	0	0	0	0	0	0	0	0
Z150	20	8	0	0	0	0	1	0	0	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z151	1	0	0	0	0	0	3	0	1	0	0
Z152	9	2	0	8	0	0	3	0	1	0	0
Z153	16	8	0	0	0	0	1	0	0	0	0
Z154	32	0	0	0	0	0	0	0	0	0	0
Z155	5	1	0	0	0	0	2	0	0	0	0
Z156	1	0	0	1	0	0	9	0	2	0	0
Z158	6	0	0	2	0	0	2	0	0	0	0
Z159	8	5	0	2	0	0	0	1	0	0	0
Z160	2	0	0	0	0	0	4	0	0	0	0
Z161	2	0	0	0	1	0	9	0	0	0	0
Z162	0	0	0	0	0	0	6	0	0	0	0
Z163	12	4	0	6	1	0	4	0	0	0	0
Z164	2	0	0	0	0	0	1	0	0	0	0
Z165	0	0	0	0	0	0	0	0	0	0	0
Z166	27	2	0	0	5	0	0	0	0	0	0
Z167	7	0	0	0	0	0	21	0	0	0	0
Z168	10	0	0	0	0	0	2	0	0	0	0
Z169	3	0	0	0	0	0	1	0	0	0	0
Z170	20	6	0	0	0	0	3	0	0	0	0
Z171	10	1	0	8	0	0	7	0	0	0	0
Z172	14	0	0	4	0	0	3	0	0	0	0
Z173	17	9	0	0	1	1	7	0	7	0	0
Z174	10	5	1	0	0	0	0	0	0	0	0
Z175	3	0	0	0	0	0	0	0	0	0	0
Z176	1	0	0	0	0	0	1	0	0	0	0
Z177	0	0	0	0	0	0	11	0	0	0	0
Z178	2	0	0	0	0	0	0	0	0	0	0
Z185	20	22	2	5	0	0	1	0	1	0	0
Z187	5	0	0	0	0	0	0	0	0	0	0
Z193	11	3	0	0	1	1	9	0	0	0	0

Code	Previous damage survey			Repetitive damage survey							
	Amount of cracks			Amount of repaired cracks	Amount of cracks increased in length and/or width		Amount of new cracks				
	Cat.A	Cat.B	Cat.C		In same category	In higher category	Cat.A		Cat.B		Cat.C
							x	y	x	y	
Z194	7	0	0	0	0	0	4	0	0	0	0
Z195	0	0	0	0	0	0	1	0	0	0	0
Z196	29	7	0	1	0	0	20	0	0	0	0
Z197	7	9	0	1	0	0	11	0	1	0	0
Z198	0	0	0	0	0	0	1	0	0	0	0
Z199	25	6	0	0	2	0	25	0	1	0	0
Z200	12	9	0	0	0	0	4	0	2	0	0
Z201	41	26	4	0	0	0	4	0	0	0	0
Z202	2	1	0	0	0	0	1	0	0	0	0
Z203	10	10	1	0	0	0	13	0	0	0	0
Z204	1	0	0	0	0	0	1	0	0	0	0
Z205	6	2	0	0	2	0	3	0	0	0	0
Z206	2	0	0	0	0	0	0	0	0	0	0
Z207	6	2	0	0	0	0	0	0	0	0	0
Z208	18	18	0	26	0	0	1	0	0	0	0
Z209	2	0	0	0	0	0	1	0	0	0	0
Z210	1	0	0	0	0	0	0	0	0	0	0
Z211	18	8	0	0	0	0	7	0	1	0	0
Z212	8	2	0	5	0	0	1	0	0	0	0
Z213	0	0	0	0	0	0	0	0	0	0	0

*) x/y: x = new crack; y = new crack in repaired one

J Triggers other than earthquake

This Table gives an overview of the buildings for which a vibration velocity is registered that has exceeded the registered vibration velocity during the earthquake.

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z2	2.3	1 trigger 2.4 mm/s cause: construction work (own house); this level is not taken into account. 2 triggers 2.3 mm/s < x <2.7 mm/s causes: unknown; this level is taken into account.	2.7
Z5	2.1	1 trigger 18.5 mm/s cause: unknown; this level is not taken into account. 4 triggers 2.1 mm/s < x <4.6 mm/s causes: unknown; this level is taken into account.	4.6
Z7	1.9	1 trigger 25.8 mm/s cause: unknown; this level is not taken into account. 1 trigger 7.3 mm/s cause: unknown; this level is taken into account.	7.3
Z9	2.2	1 trigger 7.1 mm/s cause unknown; this level is taken into account.	7.1
Z10	3.3	2 triggers 5.2 mm/s < x <38.7 mm/s causes: construction work (own house); this level is not taken into account. 2 triggers 12.7 mm/s < x <40.4 mm/s causes: sensor was hit; this level is not taken into account. 1 trigger 6.3 mm/s cause unknown; this level is taken into account.	6.3
Z12	16.3	1 trigger 21.8 mm/s cause: construction work (own house); this level is not taken into account.	16.3
Z13	14.4	8 triggers 20.0 mm/s < x <35.0 mm/s causes: construction work (own house); this level is not taken into account.	14.4
Z15	2.4	3 triggers 2.4 mm/s < x <4.4 mm/s causes: construction work (own house); this level is not taken into account.	2.4
Z16	2.2	1 trigger 3.2 cause: unknown; this level is taken into account	3.2
Z18	10.7	5 triggers 12.4 mm/s < x <31.6 mm/s causes: unknown; this level is not taken into account.	10.7
Z19	2.0	5 triggers 2.0 mm/s < x <2.9 mm/s causes: unknown; this level is taken into account.	2.9

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z21	1.4	2 triggers 1.5 mm/s < x <1.6 mm/s causes: heavy traffic on the road; this level is taken into account. 13 triggers 1.4 mm/s < x <4.3 mm/s causes: unknown; this level is taken into account.	4.3
Z22	18.0	1 trigger 23.6 mm/s cause: placing protection cap on this sensor; this level is not taken into account.	18.0
Z23	2.3	67 triggers 2.3 < x < 8.6 mm/s causes: unknown; this level is taken into account.	8.6
Z24	2.5	5 triggers 3.4 mm/s < x <8.8 mm/s causes: sensor was hit this level is not taken into account.	2.5
Z26	1.0	2 triggers 1.3 mm/s < x <1.4 mm/s causes: unknown; this level is taken into account.	1.4
Z30	1.0	1 trigger 1.2 mm/s cause: construction work (own house); this level is not taken into account. 2 triggers 1.1 mm/s < x <1.2 mm/s causes earthquake; this level is taken into account. 8 triggers 1.0 mm/s < x <1.7 mm/s causes unknown; this level is taken into account.	1.7
Z31	11.3	1 trigger 14.1 mm/s cause: cleaning of the sensor; this level is not taken into account. 9 triggers 11.8 mm/s < x <23.4 mm/s causes: construction work (own house); this level is not taken into account.	11.3
Z33	3.1	1 trigger 3.9 mm/s cause: unknown; this level is taken into account. 1 trigger 10.0 mm/s traffic; this level is taken into account. 1 trigger 24.6 mm/s. cause unknown this level is not taken into account. many triggers 3.1 mm/s < x <151 mm/s causes: construction work (own house); this level is not taken into account.	10.0
Z34	1.4	Many triggers 1.4 mm/s < x <7.2 mm/s causes: construction work (own house); this level is not taken into account.	1.4
Z35	5.1	1 trigger 42.5 mm/s cause unknown. this level is not taken into account	5.1
Z36	1.7	1 trigger 2.2 mm/s cause: earthquake; this level is taken into account.	2.2
Z37	1.8	2 triggers 1.9 mm/s and 13.6 mm/s causes: unknown; the level 1.9 mm/3 is taken into account.	1.9
Z41	2.7	1 trigger 5.6 mm/s cause: unknown; this level is taken into account.	5.6

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z42	1.1	6 triggers 1.2 mm/s < x <2.2 mm/s causes: construction work (own house); this level is not taken into account. 135 triggers 1.1 mm/s < x <3.9 mm/s causes: new sewerage is being placed in the ground; it is expected ground works will cause a vibration of the whole building; this level is taken into account 5 triggers 1.2 mm/s < x <1.9 mm/s causes causes unknown; this level is taken into account.	3.9
Z44	8.5	2 triggers 17.7 mm/s < x <19.1 mm/s causes causes unknown; this level is not taken into account.	8.5
Z45	1.7	1 trigger 5.8 mm/s cause: sensor was hit; this level is not taken into account. 1 trigger 3.6 mm/s causes: unknown; this level is taken into account.	3.6
Z47	5.2	9 triggers 9.0 mm/s < x <25.0 mm/s causes: construction work (own house); this level is not taken into account.	5.2
Z48	2.0	3 triggers 2.1 mm/s < x <2.6 mm/s causes: construction work (own house); this level is not taken into account.	2.0
Z51	2.0	1 trigger 31.4 mm/s causes: unknown; this level is not taken into account.	2.0
Z53	2.6	1 trigger 2.9 mm/s. cause: heavy traffic on the road; this level is taken into account. 1 trigger 25.0 mm/s: cause unknown; this level is not taken into account. Multiple triggers 4.3 mm/s < x < 60 mm/s. cause: construction work (own house); these levels are not taken into account. 1 trigger 9.7 mm/s. cause: unknown; this level is taken into account	9.7
Z54	1.1	2 triggers 1.3 mm/s < x <1.5 mm/s causes: unknown; this level is taken into account.	1.5
Z55	1.9	10 triggers 2.0 mm/s < x <3.8 mm/s causes: ground works in the neighbourhood; it is expected that ground works near the house will cause a vibration of the whole building; this level is taken into account 15 triggers 1.9 mm/s < x <3.0 mm/s causes: unknown; this level is taken into account.	3.8

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z57	1.1	Many triggers triggers 1.2 mm/s < x <9.6 mm/s causes: construction work (own house); this level is not taken into account. 1 trigger 4.8 mm/s cause unknown; this level is taken into account.	4.8
Z58	1.6	1 trigger 14.4 mm/s cause: sensor was hit; this level is not taken into account. 3 trigger 3.4 mm/s <5.7 mm/s causes: unknown; this level is taken into account.	5.7
Z59	1.6	1 trigger 2.2 mm/s cause: a heavy object dropped on the upper floor - it is expected that this will cause a vibration of the whole building; this level is taken into account.	2.2
Z63	1.1	2 triggers 2.1 mm/s < x <2.6 mm/s causes: unknown; this level is taken into account.	2.6
Z64	1.5	1 trigger 43.5 mm/s causes: construction work (own house); this level is not taken into account. 1 trigger 1.7 mm/s cause: traffic; this level is taken into account. 5 triggers 1.5 mm/s < x <3.9 mm/s causes unknown; this level is taken into account.	3.9
Z65	2.3	2 triggers 2.3 mm/s < x <6.0 mm/s causes: construction work (own house); this level is not taken into account. 5 triggers 2.6 mm/s < x < 5.7 mm/s causes: unknown; this level is taken into account.	5.7
Z66	3.0	3 triggers 3.3 - 5.6 - 15.8 mm/s causes: unknown; the level 5.6 mm/s is taken into account.	5.6
Z68	1.1	Many triggers 1.1 mm/s < x< 3.3 mm/s causes: unknown; this level is taken into account. 1 trigger 15.2 mm/s cause: unknown; this level is not taken into account	3.3
Z72	1.8	2 triggers 13.8 mm/s < x <35.5 mm/s causes: unknown; this level is not taken into account. 3 triggers 2.4 mm/s < x <4.6 mm/s causes: unknown; this level is taken into account.	4.6
Z74	10.9	1 trigger 16.6 cause: Maintenance sensor. this level is not taken into account	10.9
Z77	2.1	2 triggers 5.7 mm/s < x <5.8 mm/s causes: unknown; this level is taken into account.	5.8

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z78	4.5	1 trigger 6.6 mm/s cause: construction work (own house); this level is not taken into account.	4.5
Z79	1.8	Many triggers 1.8 mm/s < x <60 mm/s causes: sensor was hit; this level is not taken into account.	1.8
Z80	1.6	22 triggers 1.6 mm/s < x <3.0 mm/s causes: unknown; this level is taken into account.	3.0
Z82	1.8	1 trigger 2.1 mm/s cause: construction work (own house); this level is not taken into account. 3 triggers 1.8 mm/s < x <2.2 mm/s causes: heavy traffic on the road; this level is taken into account. 3 triggers 1.9 mm/s < x <2.2 mm/s causes: ground works in the street; it is expected that ground works will cause a vibration of the whole building; this level is taken into account. 42 triggers 1.8 mm/s < x <3.8 mm/s causes unknown; this level is taken into account.	3.8
Z84	5.4	8 triggers 6.4 mm/s < x <49.0 mm/s causes: construction work (own house); this level is not taken into account.	5.4
Z86	1.0	Many triggers up to 58.8 mm/s causes: hitting the sensor; this level is not taken into account.	1.0
Z87	1.9	1 trigger 2.2 mm/s cause: works in the street; it is expected that ground works near the house will cause a vibration of the whole building; this level is taken into account. 22 triggers 1.9 mm/s < x <3.8 mm/s causes: unknown; this level is taken into account.	3.8
Z88	2.2	2 triggers 2.3 mm/s < x <2.9 mm/s causes: sensor was hit; this level is not taken into account.	2.2
Z89	3.4	1 trigger 4.7 mm/s cause: sensor was hit; this level is not taken into account.	3.4
Z90	1.7	3 triggers 2.3 - 3.0 - 14.4 mm/s causes: unknown; the level 3.0 mm/s is taken into account.	3.0
Z92	1.6	Many triggers 1.6 mm/s < x <3.5 mm/s causes: traffic; this level is taken into account. 3 triggers 14.0 - 39.0 mm/s causes: sensor was hit; this level is not taken into account	3.5
Z95	2.6	Many triggers 4.2 mm/s < x <9.7 mm/s causes: sensor was hit; this level is not taken into account	2.6

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z96	1.0	2 triggers 16.5 mm/s and 14.3 causes: unknown; this level is not taken into account. Many triggers 1.0 mm/s < x <4.9 mm/s causes unknown or heavy trucks passing by; this level is taken into account.	4.9
Z98	1.1	Many triggers 1.2 mm/s < x< 3.2 mm/s causes: construction work (own house); this level is not taken into account.	1.1
Z99	2.1	Many triggers 2.1 mm/s < x< 9.5 mm/s causes: unknown; this level is taken into account. 2 triggers 15.7 and 20.6 mm/s causes: unknown; this level is not taken into account	9.5
Z100	3.6	1 trigger 4.4 mm/s cause: unknown; this level is taken into account.	4.4
Z102	2.6	1 trigger 6.0 mm/s cause: unknown; this level is taken into account.	6.0
Z104	2.0	2 triggers 2.4 mm/s < x< 4.7 mm/s causes: construction work (own house); this level is not taken into account. 2 triggers 2.3 mm/s < x < 2.8 mm/s causes: heavy container was places 10m from the sensor. it is expected that impact of heavy container near the house will cause a vibration of the whole building; this level is taken into account. 1 trigger 4.3 mm/s causes: unknown; this level is taken into account.	4.3
Z106	2.3	1 trigger 31.0 mm/s cause: sensor was hit; this level is not taken into account.	2.3
Z108	1.7	2 triggers 3.0 mm/s < x< 4.9 mm/s causes: unknown; this level is taken into account.	4.9
Z109	2.7	2 triggers 4.8 mm/s < x <27.6 mm/s causes: construction work (own house); this level is not taken into account.	2.7
Z110	3.3	2 triggers 20.4 and 29.5 mm/s causes: unknown; this level is not taken into account. 6 triggers 3.8 mm/s < x< 8.7 mm/s causes: unknown; this level is taken into account.	8.7
Z111	23.8	1 trigger 28.1 mm/s cause: construction work (own house); this level is not taken into account.	23.8
Z112	4.7	1 trigger 5.6 mm/s causes: unknown; this level is taken into account.	5.6
Z116	16.1	4 triggers 16.3 mm/s < x< 20.3 mm/s causes: unknown; this level is not taken into account.	16.1

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z120	3.3	6 triggers 4.3 mm/s < x <31.1 mm/s causes: construction work (own house); this level is not taken into account.	3.3
Z122	4.1	2 triggers 4.2 mm/s < x< 68.1 mm/s causes: construction work (own house); this level is not taken into account. 1 trigger 6.4 mm/s causes: unknown; this level is taken into account.	6.4
Z126	2.3	22 trigger 2.3 mm/s < x <174.4 mm/s causes: construction work (own house); this level is not taken into account. 1 triggers 3.8 mm/s causes: traffic; this level is taken into account.	3.8
Z127	4.5	1 trigger 15.3 mm/s cause: construction work (own house); this level is not taken into account.	4.5
Z128	12.8	1 trigger 13.9 mm/s causes: unknown; this level is not taken into account.	12.8
Z132	1.6	2 trigger 3.3 mm/s < x <18.1 mm/s causes: sensor was hit; this level is not taken into account.	1.6
Z134	1.8	1 trigger 28.1 mm/s causes: unknown; this level is not taken into account.	1.8
Z135	2.5	2 triggers 5.2 mm/s < x< 5.8 mm/s causes: construction work (own house); this level is not taken into account. 1 trigger 42.1 mm/s cause: unknown; this level is not taken into account. 1 trigger 3.7 mm/s cause: unknown; this level is taken into account.	3.7
Z136	1.8	5 triggers 1.9 mm/s < x< 4.8 mm/s causes: construction work (own house); this level is not taken into account.	1.8
Z142	9.2	5 trigger 9.5 mm/s < x <30.1 mm/s causes: construction work (own house); this level is not taken into account.	9.2
Z143	1.6	4 triggers 1.6 mm/s < x< 4.8 mm/s causes: construction work (own house); this level is not taken into account. 1 trigger 2.1 mm/s cause: heavy traffic; this level is taken into account. 1 trigger 2.6 mm/s cause: unknown; this level is taken into account.	2.6
Z144	3.3	1 trigger 8.1 mm/s cause: unknown; this level is taken into account.	8.1

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z145	2.1	4 triggers 2.3 mm/s < x< 44.4 mm/s causes: sensor was hit; this level is not taken into account. 4 triggers 2.3 mm/s < x< 4.3 mm/s causes: construction work (own house); this level is not taken into account. 5 triggers 2.3 mm/s < x< 5.3 mm/s causes: unknown; this level is taken into account. 1 triggers 23.8 mm/s cause: unknown; this level is not taken into account.	5.3
Z146	1.7	2 triggers 1.9 mm/s < x< 2.4 mm/s causes: sensor was hit; this level is not taken into account. Many trigger until 1.9 mm/s cause: traffic; this level is taken into account. Many triggers until 3.2 mm/s causes: unknown; this level is taken into account. 1 trigger 22.5 mm/s cause: unknown; this level is not taken into account.	3.2
Z147	4.4	2 triggers 5.1 mm/s cause: sensor was hit; this level is not taken into account. 4 triggers 4.6 mm/s < x< 6.2 mm/s causes: unknown; this level is taken into account.	6.2
Z152	1.6	3 trigger 1.6 mm/s < x <3.0 mm/s causes: construction work (own house); this level is not taken into account.	1.6
Z154	2.7	Many triggers 2.7 mm/s < x< 4.5 mm/s causes: sensor was hit; this level is not taken into account.	2.7
Z155	2.4	3 triggers 6.0 mm/s < x< 12.3 mm/s causes: sensor was hit; this level is not taken into account. 1 trigger 3.0 mm/s cause: unknown; this level is taken into account.	3.0
Z156	1.8	2 triggers 3.2 mm/s < x< 4.5 mm/s causes: construction work (own house); this level is not taken into account. 3 triggers 23.2 mm/s < x< 99.6 mm/s causes: unknown; this level is not taken into account. 1 trigger 3.0 mm/s cause: unknown; this level is taken into account.	3.0
Z160	5.8	1 trigger 23.0 mm/s mm/s cause: unknown; this level is not taken into account.	5.8
Z161	1.3	1 trigger 2.3 mm/s mm/s cause: unknown; this level is taken into account.	2.3
Z166	2.2	1 trigger 2.7 mm/s cause: unknown; this level is taken into account.	2.7

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z167	1.6	7 triggers 1.9 mm/s < x< 6.9 mm/s causes: unknown; this level is taken into account. 4 triggers 13.2 mm/s < x< 24.5 mm/s causes: unknown; this level is not taken into account.	6.9
Z168	1.1	3 triggers 1.5 mm/s < x< 2.0 mm/s causes: unknown; this level is taken into account.	2.0
Z169	1.1	1 trigger 1.8 mm/s cause: unknown; this level is taken into account.	1.8
Z170	1.0	6 triggers 1.2 mm/s < x< 2.4 mm/s causes: unknown; this level is taken into account.	2.4
Z172	2.2	4 triggers 2.4 mm/s < x < 12.2 mm/s causes: hitting the sensor; this level is not taken into account. Many triggers 2.2 mm/s < x< 8.5 mm/s causes: unknown; this level is taken into account. 9 triggers 10.5 mm/s < x< 46.7 mm/s causes: unknown; this level is not taken into account.	8.5
Z176	1.7	12 triggers 1.8 mm/s < x< 4.7 mm/s causes: unknown; this level is taken into account.	4.7
Z177	2.7	1 triggers 2.8 mm/s causes: hitting the sensor; this level is not taken into account. 2 triggers 4.0 mm/s and 4.3 mm/s causes: unknown; this level is taken into account. 2 triggers 10.3 mm/s and 24.0 mm/s causes: unknown; this level is not taken into account.	4.3
Z185	3.2	Many triggers 3.3 mm/s < x< 9.3 mm/s causes: unknown; this level is taken into account. 1 triggers 10.2 mm/s cause: unknown; this level is not taken into account.	9.3
Z187	2.2	3 triggers 25.6 – 41.0 mm/s. causes: unknown; these levels are not taken into account.	2.2
Z196	1.1	5 triggers 1.2 mm/s < x< 2.2 mm/s causes: unknown; this level is taken into account.	2.2

Code	Maximum registered vibration velocity v_{max} (mm/s)		
	Earthquake Zeerijp	Other triggers (maximum value of both vertical and horizontal component)	Taken into account
Z197	1.3	Many triggers 1.3 mm/s < x< 2.7 mm/s causes: works in the street; it is expected that ground works near the house will cause a vibration of the whole building; this level is taken into account. 3 triggers 1.4 mm/s < x< 2.1 mm/s causes: construction work (own house); this level is not taken into account. 3 triggers 1.6 mm/s < x< 2.3 mm/s causes: unknown; this level is taken into account. 1 triggers 12.5 mm/s cause: unknown; this level is not taken into account.	2.7
Z202	4.2	Two triggers 24.7mm/s and 71.7 mm/s. causes: unknown; these levels are not taken into account.	4.2
Z203	3.5	8 triggers 3.6 mm/s < x< 10.0 mm/s causes: unknown; this level is taken into account. 5 triggers 15.5 mm/s < x< 84.1 mm/s cause: unknown; this level is not taken into account.	10.0
Z204	1.4	1 trigger 28.8 mm/s cause: unknown; this level is not taken into account.	1.4
Z211	1.2	1 trigger 18 mm/s cause: unknown; this level is not taken into account.	1.2
Z212	13.2	8 triggers 2.5 - 600 mm/s. causes: hitting the sensor; these levels are not taken into account	13.2
Z213	2.5	2 triggers 20.3 and 27.1 mm/s. causes: unknown; these levels are not taken into account. 2 triggers 27.6 mm/s. causes: hitting the sensor; these levels are not taken into account.	2.5