SYSCOM Instruments

Vibration monitoring,
Basel, Switzerland

Case study

October 2020

Evaluation of soil vibrations for a new construction in Basel, Switzerland

Abstract

The Natural History Museum and the State Archive Basel-Stadt are housed in old properties of the city of Basel, located in the North of Switzerland. Both institutions suffer from inadequate conditions in their magazines and warehouses, which poses a significant threat to the valuable archives and collections. For this reason, a new building is planned on a former railway area on Entenweidstrasse. In the south and west it borders on the track area of the railway while in the north it is very close to the Luzernerring bridge (Figure 1 and Figure 2).

The vibrations generated by the trains passing on the railways are transmitted through the ground and can lead to disturbing radiated sound (so-called structure-borne sound).

The company Ziegler Consultants, representative of Syscom in Switzerland, is commissioned by the Department of Construction and Transport of the Canton of Basel-Stadt to clarify whether this situation can lead to disturbing vibrations and audible structure-borne noise immissions and, if so, which measures are necessary to reduce such immissions.

In the summer of 2018 it was decided to carry out vibration measurements in boreholes to deeply evaluate the soil conditions. Special velocity sensors MS2003+ were used for the measurements.

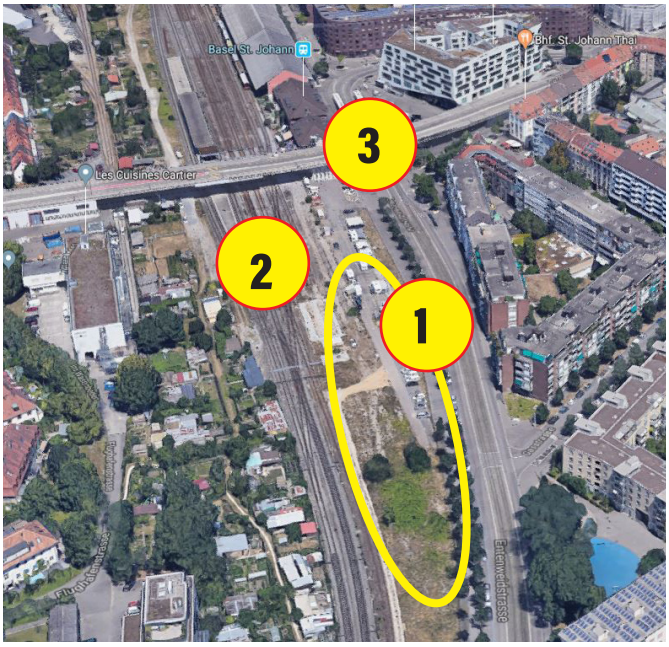

Figure 1. Top view of surroundings of Entenweidstrasse: 1) The area where the new building is under construction. 2) The railway. 3) The Luzernerring bridge.

Monitoring Summary

City:	Basel, Switzerland	Sensors:	6 uniaxial vertical velocity sensors MS2003+, 2 on the surface and 4 in the boreholes
Objective:	Evaluation of the soil vibrations where the new building will be constructed.	Output:	Maximum velocities and frequency range in 2 locations, at different depth in the ground.
Duration:	1 week, to be repeated after one year		

Figure 2. The construction site with a driller machine.

Monitoring configuration

For the underground measurements 4 borehole sensors made by Syscom with the following characteristics are used:

- uniaxial velocity sensors
- measuring in the vertical direction
- IP68 box

The sensors are fixed to a flexible glass-reinforced plastic rod to make the installation easier (Figure 3). Then they are inserted in the ground at different depths, in boreholes with a diameter of 260 mm. While pulling the casing, the boreholes in the area of the sensors are filled with quartz sand.

Moreover, other 2 sensors are installed on the surface, measuring also in the vertical direction, for a total of 6 sensors in 2 different measurement points. The exact position of all sensors is indicated in Table 1.

Figure 4 shows the measurement point MP1, with the recorder MR3000TR, a junction box for the connection to the 3 external sensors, the surface sensor and the underground sensors. Figure 5 shows the preparation of the instruments for the measurement point MP2.

The measurements in MP1 are carried out from 17.09.2018 at 12:30 until 21.09.2018 at 14:30. In MP2, measurements are taken from 11.09.2018 at 15:00 to 17.09.2018 at 09:00. The sampling frequency is set to 800 Hz.

Table 1. Position of the measuring points.

Measuring points	Recorder	Position of each uniaxial sensor
MP1	MR3000TR	**1a**: on the surface **1b**: -10 m under the ground **1c**: -19 m under the ground
MP2	MR2002-CE	**2a**: on the surface **2b**: -10 m under the ground **2c**: -19 m under the ground

Figure 4. Measurement point MP1. 1) The recorder MR3000TR. 2) A junction box for the connection to the three external sensors. 3) The sensor at the surface. 4) The underground sensors.

Figure 3. Borehole sensor ready to be inserted in the ground.

Figure 5. Preparation of the instruments for MP2.

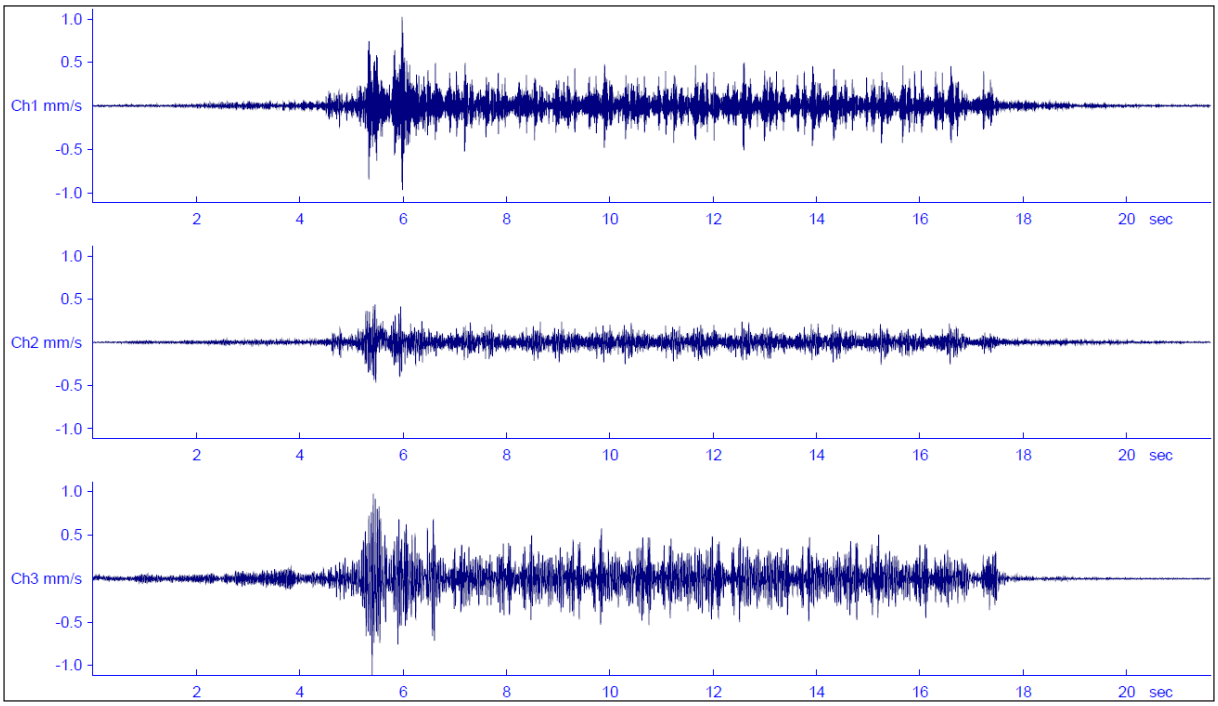

Figure 5. Event recorded in MP2 during a train transit. The first signal refers to the surface sensor, the second to the sensor at 10 m depth and the third for the sensor at 19 m depth.

Monitoring results

During the monitoring period, almost 300 train transits are recorded at MP1 and more than 700 at MP2.

In Table 2, the maximum values for each measurement points are listed. For both units, the sensor at 10 m depth has the lowest vibrations. The sensor at 19 m depth is the one with the highest values (MP1) or with values very close to the surface sensor (MP2).

A typical event recorded in MP2 during the transit of a train is shown in Figure 5. High velocity values are recorded for at about 13 seconds. The FFT related to the event, shown in Figure 6, highlights low frequencies (approximately between 20 and 50 Hz) for the underground sensors, with an evident maximum at about 30 Hz, and a wider range (about 12-125 Hz) for the surface sensors.

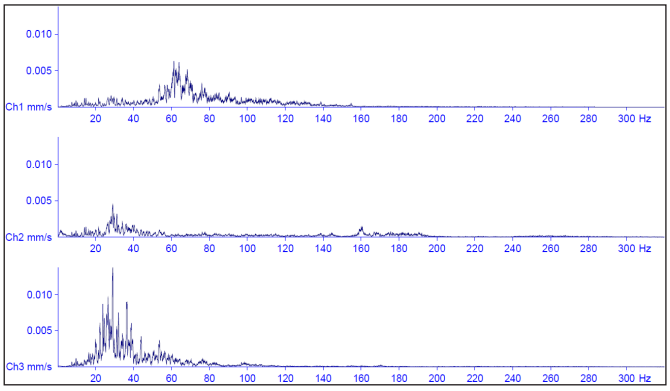

Figure 6. FFT related to the event of Figure 5.

Table 2. Maximum velocities recorded during the monitoring.

Meas. points	1a	1b	1c	2a	2b	2c
Max (mm/s)	0.55	0.38	1.01	1.27	0.81	1.25

Conclusion

The measurements done in Basel with surface and borehole sensors have given interesting information about the soil vibrations on the site.

It is planned to perform new measurements in 2021 during and after excavation works for the construction, to compare the new results with those shown in this document.

Special thanks to Ziegler Consultants who allowed us to write this case study.

About Syscom

SYSCOM Instruments is part of Terra Insights platform of trusted monitoring technology brands. Terra Insights is the industry's first, end-to-end sensor to cloud data delivery platform that supports proactive, risk-informed decision making and monitoring. SYSCOM Instruments SA is a leading supplier of vibration and seismic monitoring equipment for the civil engineering and safety markets, in particular for nuclear power plants and LNG plants.
The reputation of SYSCOM Instruments SA is based on the reliability of its products, resulting from a meticulous control of all aspects of design and production.

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