Pre-Construction Vibration Assessments: Impact of Train-Induced Vibration on Buildings

CASE STUDY: A Comparison of FFT and 1/3 Octave Methods Across Four Standards

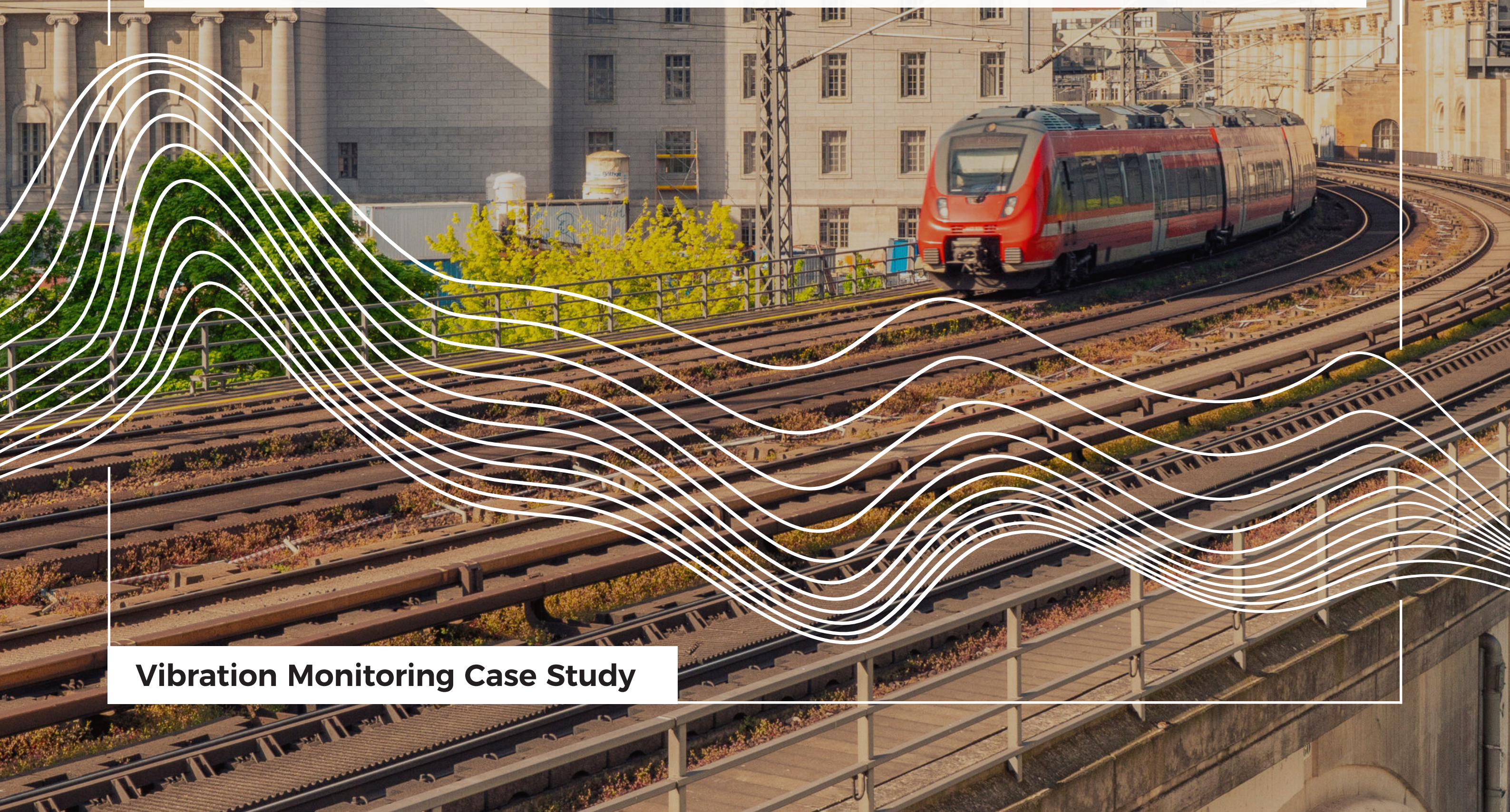
Measurement Operator:

SVANTEK Consultants

Measurement Equipment:

SV 803 Vibration Monitoring Station
SVAN 958A 4-Channel Vibration & Noise Analyzer
SvanPC++ Post-Processing Software

Challenge:
To evaluate real vibration levels induced by train traffic on a building structure using different international standards. The goal was to demonstrate how the same vibration event can lead to varying assessments depending on the applied methodology.



Vibration Monitoring Case Study

This case study explores a vibration monitoring experiment conducted on the foundation slab of a multi-storey building located approximately 30 meters from active railway tracks. Using the **SV 803** monitoring station and **SVAN 958A** analyzer, the research team set out to compare how four different standards assess vibration impact on buildings:

- DIN 4150-3 (Germany)
- BS 7385-2 (UK)
- IEST VC Curves (USA)
- PN-B-02170 (Poland)

Controlled Measurement Conditions

To ensure accurate and uncontaminated results, measurements were conducted during a scheduled break in construction activities. This strategic decision eliminated ambient noise and vibration from machinery, ensuring that only the vibrations generated by passing trains were recorded. During a 22-minute measurement session, eight individual train passages were captured, providing a representative dataset for analysis under varying vibration conditions.

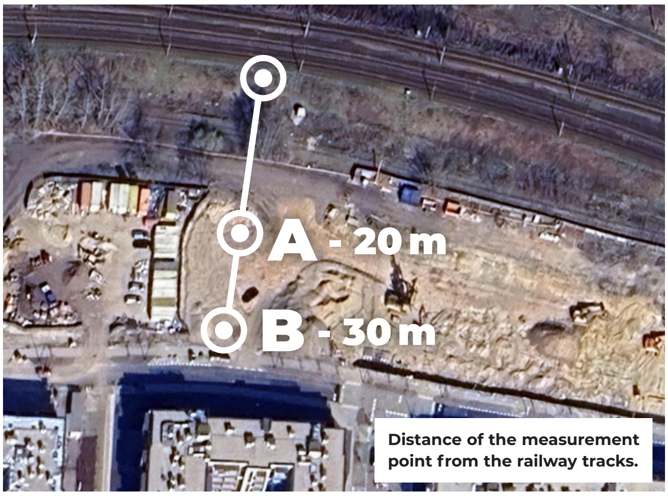
Two-Point Monitoring Setup and Foundation Attenuation

A dual-point sensor layout was implemented to study the propagation of ground vibrations through the building structure:

Point A – Ground Measurement: A vibration sensor was mounted on a 0.5-meter spike embedded in the soil, approximately 20 meters from the railway tracks.

Point B – Structural Measurement: A second sensor was mounted on the building's foundation slab, positioned 30 meters from the tracks. The sensor was attached in accordance with DIN 45669-2.

The contrast in measured amplitudes between Point A and Point B clearly demonstrated the attenuation effect of the concrete structure. Vibrations measured at the foundation slab were significantly lower than those in the surrounding soil.



This observation is consistent with ISO 4866, which recommends measuring the soil–foundation transfer function to understand how building mass, soil elasticity, and wave transmission alter incoming ground vibrations. This function is crucial for realistic assessment of structural impacts, particularly in rail-adjacent developments.

Data Collection & Analysis

The **SV 803** was configured to perform measurements in compliance with DIN 4150-3, using the FFT method to identify dominant frequencies and peak particle velocities (PPV). Simultaneously, the station logged raw time-domain waveform data, which was later processed in **SvanPC++** using 1/3 octave filters. This enabled cross-standard analysis using all four methodologies.

- Measurements captured vibration velocity in three axes: X, Y, and Z.
- Full FFT spectra and waveform recordings were triggered automatically when PPV thresholds were approached.

- Post-processing in **SvanPC++** allowed reinterpretation of the same event using IEST VC curves and PN-B-02170 methods.

Key Observations

The highest vibration amplitude (8.3 mm/s) occurred in the X-axis, perpendicular to the railway tracks.

DIN 4150-3 and BS 7385-2 concluded that the vibration levels posed no threat to the structure.

Structural attenuation was clearly visible: values at Point B (foundation plate) were consistently lower than at Point A (soil).

In contrast, IEST VC curves and PN-B-02170 assessed the same event as potentially damaging to sensitive equipment and even the building itself.

Filtering via 1/3 octave bands modified peak values compared to raw time-domain signals, which can lead to different conclusions.

Conclusion

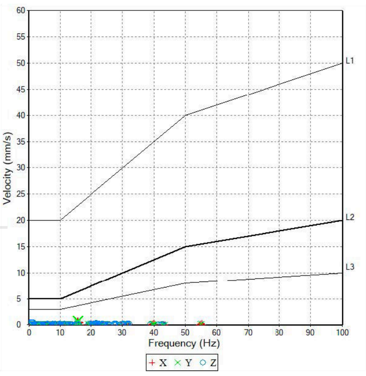
This study underscores a critical insight:

The same vibration event may be interpreted in dramatically different ways depending on the measurement method and standard applied.

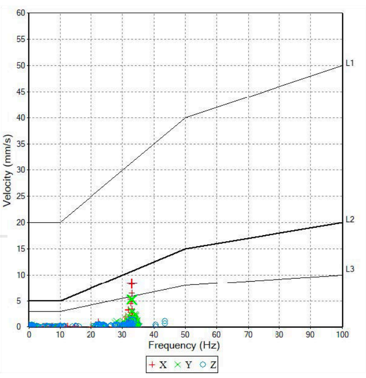
While FFT-based PPV standards such as DIN and BS identified no structural risk, analysis using 1/3 octave band peak values (PN-B-02170 and IEST VC) flagged the same event as hazardous. This divergence in interpretation emphasizes the importance of selecting the appropriate methodology for each monitoring context.

It also highlights the relevance of foundation attenuation, which must be considered to avoid overestimating risks based on ground-level data alone.

Vibration time history at the point A (mounting spike) analysed by SVAN 958A.



Vibration time history at the point B (foundation plate) analysed by SV 803.



Key Takeaways:

1. Measurement standards differ not only in acceptable limits but also in how vibration data is processed and interpreted.

2. FFT vs. 1/3 octave analysis methods yield different peak values from the same event because of different signal processing approach.

3. Structural elements such as foundation slabs significantly reduce vibration amplitudes – a factor that should always be considered.

4. Reliable vibration assessment requires a holistic approach, accounting for standard selection, data filtering, and structural context.

5. This multi-standard comparative approach, powered by **SV 803**'s robust data acquisition and detailed **SvanPC++** post-processing, offers a powerful model for evaluating structural safety near railway lines and other vibration-intensive environments.

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