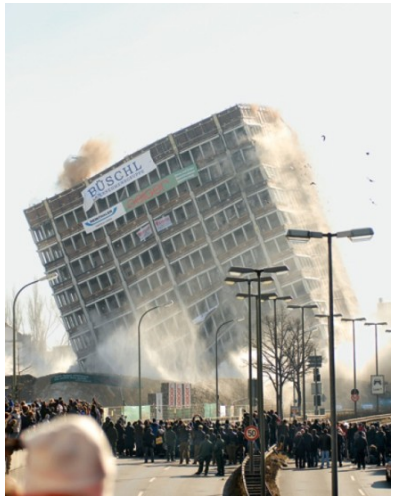
Structural Vibration Measurement with the VM40C Vibration Monitor

Why Measure Structural Vibration?

- Buildings and other large structures like bridges, tunnels or pipelines are exposed to vibration.
- Buildings must sustain vibrations, structural integrity and bearing capacity of ceilings and other components has to be ensured.
- Historic buildings require special attention.
- Vibrations may affect habitability and working conditions.

Sources of Building Vibration

- Construction activities
- Industrial machinery
- Road traffic
- Railway lines
- Explosions



Goals of Building Vibration Measurement

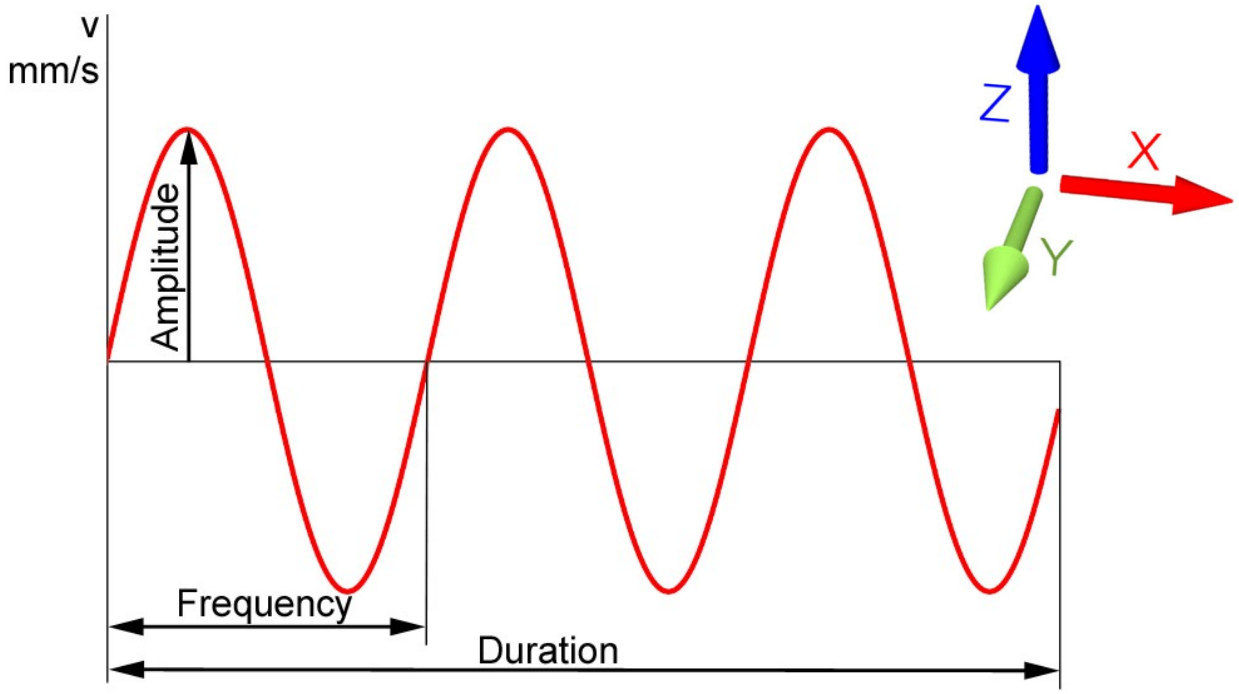
- Problem recognition: Occupants of a building report that a building is vibrating, measurements are carried out to evaluate the risk for structural integrity
- Control monitoring: Maximum permissible vibration values have been established and those vibrations have to be measured
- Documentation: Measurements are made to verify predictions of response in the design of a building
- Diagnosis: Measurements are made at deeper levels of investigation to provide information for mitigation procedures

Catastrophic Failure

- Collapse of Rana Plaza commercial building in Dhaka (Bangladesh) in 2013
- Vibrations due to power generators overloaded the Building structure
- Vibrations and cracks were ignored
- Death toll 1134

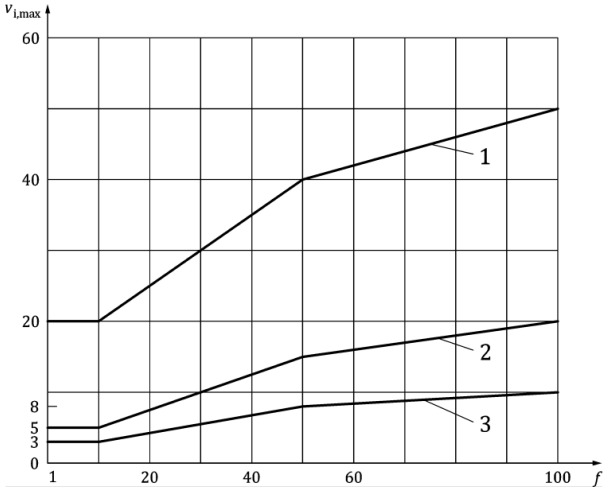
Parameters of Excitation

- Amplitude
- Frequency
- Duration
- Direction



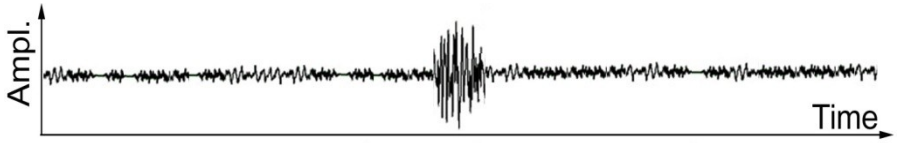
Guide Values

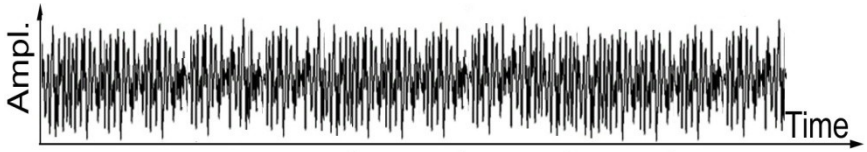
- Some standards, like the German DIN 4150-3, give reference values based on the experience of a large number of practical measurements.
- At vibration amplitudes below these guide values damages are unlikely.
- If results are above the guide values a deeper analysis should be made.



Types of Structural Vibration

Transient Vibrations	Continuous Vibrations
• Not strong enough to cause material fatigue • Too short and too rare to be increased by resonances	• May cause material fatigue • Resonances may increase vibration magnitudes



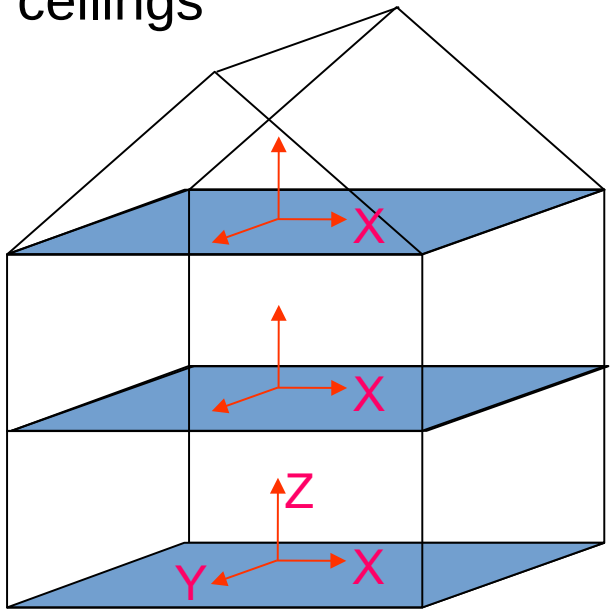


Standards for Building Vibration (Examples)

- German DIN 4150-3 with various derivatives in other countries: Vibration in buildings - Part 3: Effects on structures
- British BS 7385: Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration
- Swiss SN 640312a: Vibration immission in buildings
- ISO 4866: Mechanical vibration and shock - Vibration of fixed structures - Guidelines for the measurement of vibrations and evaluation of their effects on structures
- French Circulaire du 23/07/86

Measurement Points

- Building vibration is measured in 2 directions (X/Y) or 3 directions (X/Y/Z)
- Typical measurement points are the foundation and ceilings



The VM40C Vibration Monitor

- Includes triaxial high sensitivity accelerometer
- Monitors peak value of velocity or acceleration
- Supports several international standards

The VM40C Vibration Monitor

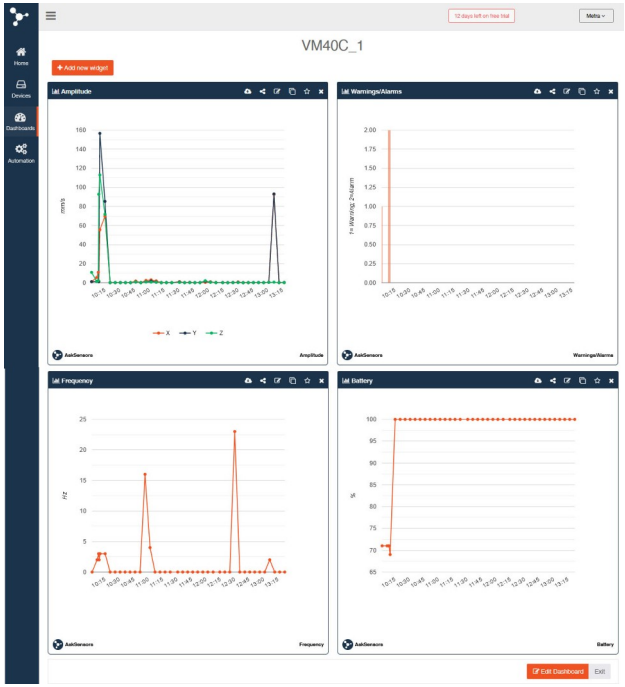
- Rechargeable battery for autonomous operation
- Memory for recording, USB interface
- Rugged design for outdoor operation

Cellular Network Connectivity

- Optional 4G (LTE) cellular modem
- SMS sent at alarm events
- HTTP data communication with IoT platforms

Connection to IoT Measurement Data Platforms

- Uses 4G (LTE) cellular modem
- HTTP communication with sensor data platforms
- Provides remote access to current and historic vibration data



Radio-Controlled Alarm Beacon Light

- For remote alerting in construction machinery etc.
- Uses efficient long-range (LoRa) radio communication standard
- Reaches over 1 km in free range
- Battery operated

External Processing of Measurement Data

- PC software for data from internal memory
- Report generation, archiving and visualization