SYSCOM Instruments

February 2022

Case study
Tailing Storage Facility (TSF) dam monitoring using ambient vibrations, Brazil

Case study - TSF dam monitoring using ambient vibrations

Introduction

The Tailing Storage Facility (TFS) dam at the Serra Azul mine is under online remote vibration monitoring using four MR3000C devices, transmitting the relevant vibration data in real-time to the Syscom Cloud Software - SCS. Two devices are equipped with an internal velocity meter and two others with an internal accelerometer.

The dam structural dynamics, the earth and sub-soil structure and other geotechnical monitored parameters ensure that the overal geological system is remaining stable over time and won't reach any critical structural failure without pre-emptive signs. Trusted data is crucial for risk informed decision making in this case.

The tailings storage facility (TSF) is a structure made up of one or more dams built for the purposes of storing the uneconomical ore and water from the milling process. Traditionally vibration monitoring devices are used to monitor amplitudes according to some pre-defined limit criteria.

On site, the MR3000C device, equipped with an internal MEMS accelerometer, is used for different purposes at the same time:

- monitoring of the peak ground amplitudes
- FDD, Frequency Domain Decomposition
- HVSR, H/V spectral ratio aslo referred as Nakamura method

FDD and HVSR are both spectral evaluations.

Description of the mine with key facts

Country:	Brazil, Belo Horizonte
Name:	Serra Azul
Location:	Igarapé, MG, Brazil
Owner:	Mineração Morro do Ipê mining company
Extract volume:	Six million tons m3 (2021)
Commodity:	Iron ore

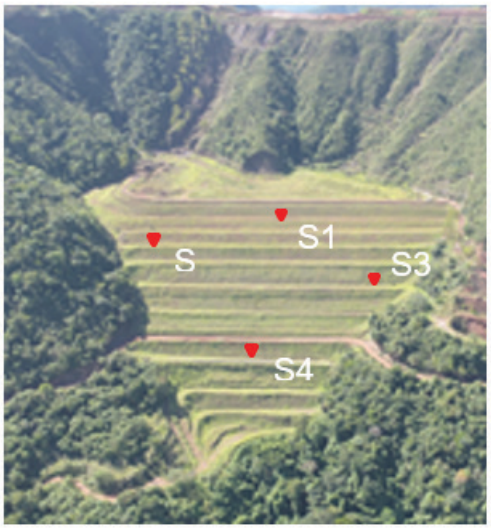

Figure 1: TSF mine view frontal view with devices location

Monitoring PPV amplitudes

Amplitude (peak particle velocity) is monitored since April 2020 (Figure 2). Syscom MR3000C built-in 4G modem provide communication with the SCS - Syscom Cloud Software. Background periodic recording and triggered events are available for the client as soon as they are recorded.

SMS and Email alert notifications are delivered when a pre-defined limit is exeeded. This is to ensure that no unexpected vibrations are happening on the mine site, essentially for safety measures.

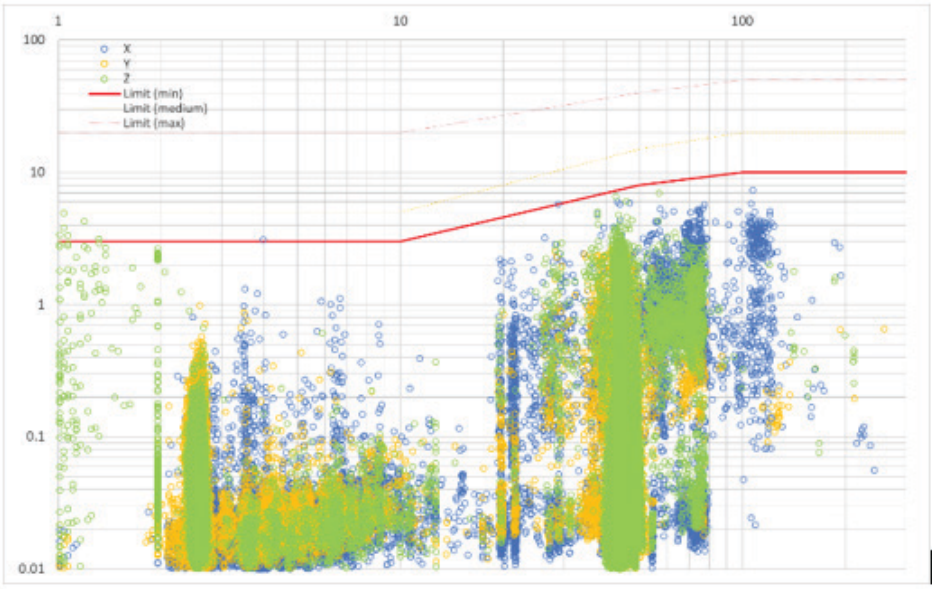

Figure 2: Monthly amplitude (mm/s) vs Frequency (Hz)

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Spectral analysis by Frequency Domain Decomposition (FDD)

Natural frequencies are monthly monitored since August 2019. A FDD procedure is performed under time history and peaks are observed. The time history are recorded by the MR3000C Syscom devices and data are processed using Geopsy software. Since vibration spectra may contain natural and operational modes, a continuous vibration monitoring is required to identify peaks due to natural vibrations (Figure 3).

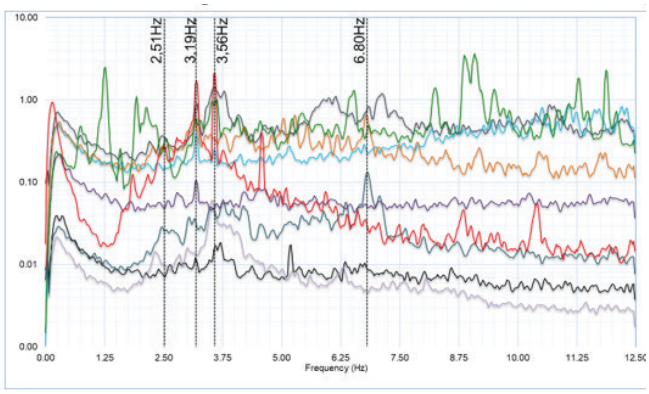


Figure 3: Nine last spectra and four possible natural frequencies

Spectral analysis by H/V spectral ratio (HVSR)

With the goal to understand the relation between horizontal and vertical amplitudes, HVSR analysis is observed since January 2021 (Figure 4). A recomended method is shown hereunder. Ambient vibration signals must be adequately selected by avoiding recorded peaks due to human activities.

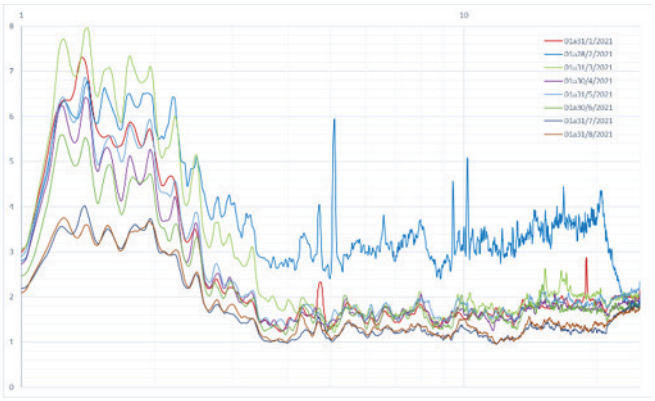


Figure 4: Eight last HVSR values vs frequency (Hz)

Other geophysical methods

Geopsy (https://www.geopsy.org/, other software available as well for this kind of analysis) provides tools for processing ambient vibrations with site characterization. Geopsy is typically used for FDD and H/V post-processing methods performed by a qualified geophysicist.

Other geophysical methods for sub-soil investigation may also include MASW, CPT, SPT among other methods, usually relevant for design codes (Eurocode 8 for example) and classification of soil condition based on shear-wave velocity V_{s30} at 30m depth.

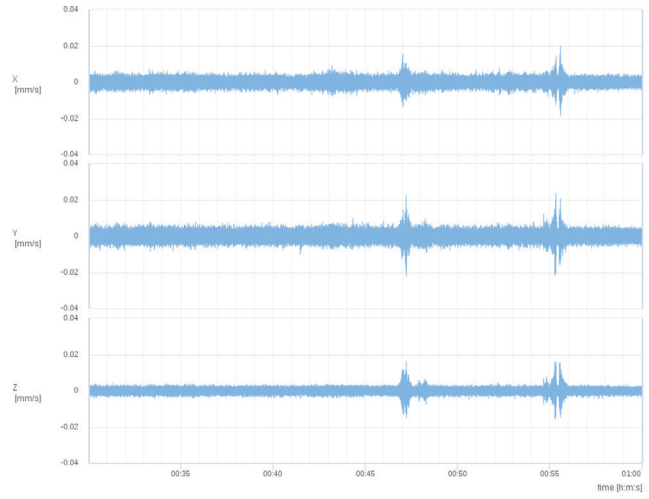
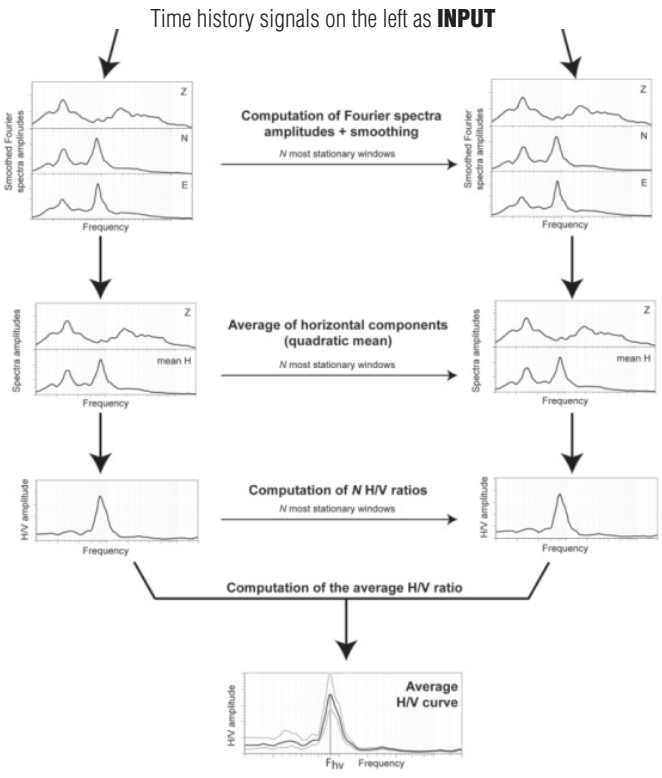


Figure 5: 30 minutes horizontal and vertical ambient vibration recording with the XY-Horizontal and Z-Vertical time history signals for Geopsy HVSR post-processing in order to get the H/V average curve. Recorded peaks during the 30 minutes recording should be removed for the post-processing analysis.



Source: www.geopsy.org

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Instrumentation

Syscom MR3000C is the perfect instrument for TSF dam monitoring for real-time permanent vibration monitoring.

Having the capability of an internal acceleration sensor or velocity sensor, it is suitable for a wide range of applications.

Among its best features, the built-in 4G modem enable smooth data transmission to any platforms. Typical interfacing can be done using comprehensive APIs, easy to implement FTP forward data or the use of the Syscom Cloud Software for easiest data gathering, processing and automated notifications.

Providing 24 bits resolution and achieving very low noise (typically 0.1 um/s over a 100Hz bandwidth!), especially for the model with internal geophones, it is very much suitable for ambient vibration monitoring.

The MR3000 product lines are now updated and replaced by MR3003 product lines, an even more powerful and versatile range of devices.

Additional information can be found on the Syscom website, about MR3003 product lines and the Syscom Cloud Software:

www.syscom-instruments.com

Figure 6: MR3003C device with internal acceleration or velocity sensor, suitable for ambient vibration monitoring on TSF dams.

Conclusion

Structural monitoring is being done over the earth dam located at the Serra Azul region. Amplitudes, FDD and HVSR technics are used considering the same MR3000C setup.

Possible natural frequencies were found and are periodically monitored. The TSF dam is permanently monitored and any deviations in its structural and geotechnical parameters will be detected for risk based evaluation.

For more information about the study and the instruments, please contact SysCREAR or Syscom Instruments at the contact details below.

We are grateful to our partner SysCREAR for allowing us to write this case study.

http://syscrear.com.br/

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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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