CHIMNEY DYNAMIC TEST

Introduction

Monitoring of structure movements and vibrations (bridges, buildings, monuments, towers etc.) is an increasingly important task for today's construction engineers. **IBIS-S** introduces a totally new solution in this field of application, with many advantages over traditional instruments for both static and dynamic monitoring:

- remote sensing at a distance of up to 1 km
- displacement accuracy up to 1/100 mm
- real-time one-dimensional simultaneous mapping of all displacement detected on the structure
- fast installation and operation
- the same instrument can be used for static and dynamic monitoring
- structure vibration rate up to 200 Hz
- operates day-night, in all weather conditions

Fig. 1: IBIS-S

Hereinafter the results from an investigation performed on a chimney are given as an example of dynamic monitoring of vertical structures. The experimental results consist of:

- visualisation of the displacement of some points on the chimney;
- identification of the resonance frequencies of the structure;
- identification of modal shapes.

Measure description

One of the advantages of using IBIS-S for dynamic tests of vertical structures is the capability to perform remote sensing, without the need of accessing the structure to install sensors or optical targets. In fact, each discontinuity of the structure – such as the roughness of the surface - represents a potential source of reflection of the electromagnetic waves generated by the system.

In order to exploit this key feature for chimney monitoring, the best position to install the sensor is at the bottom of the chimney so that IBIS-S antenna beam can cover the entire height of the chimney, as illustrated in the figure below.

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In the described measure IBIS-S was installed at about 50m far from the chimney. From this position IBIS-S monitored the chimney from 70m height to the top (183m).

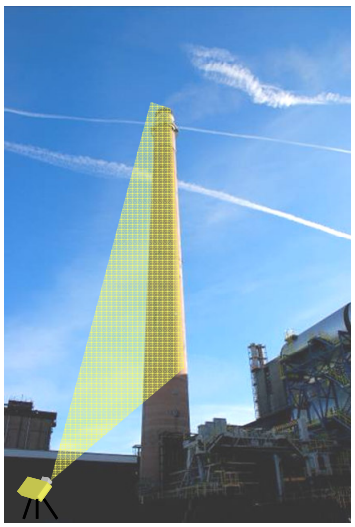

Fig. 2: IBIS-S installation

The system was configured with the following operational parameters:

- maximum range: 300 m
- sampling rate: 50 Hz
- range resolution: 0.5 m

The figure below shows the image of the chimney acquired by IBIS-S: the plot shows several peaks corresponding to the measurement points on which the analysis will be carried out.

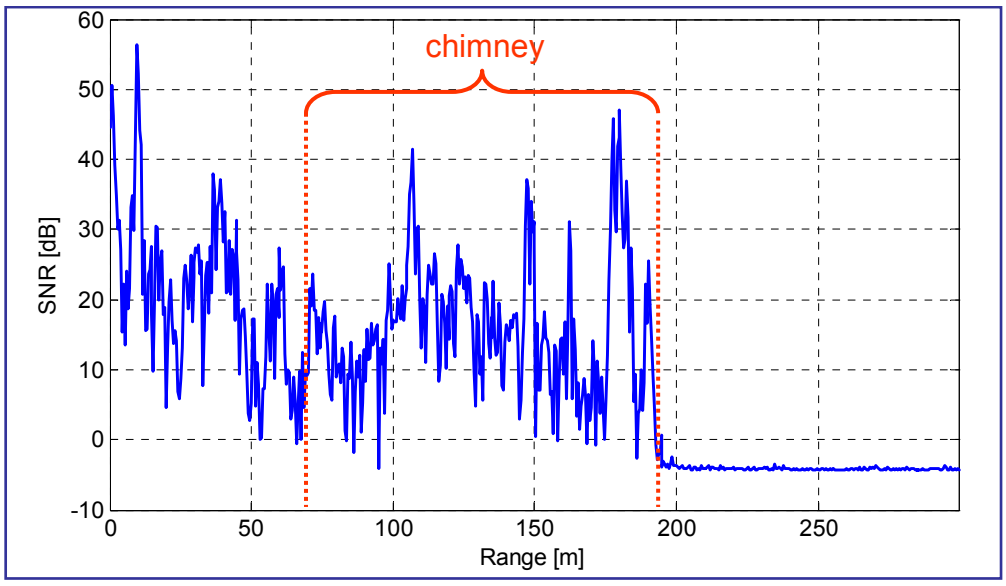

Fig. 3: Distance profile (radar image)

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Results - Displacement data

As IBIS-S raw data is the displacement of the targets belonging to the illuminated scenario, the following figures show the displacement data of some of the selected measurement points for the entire duration of the measure and for a temporal zoom of 30 seconds.

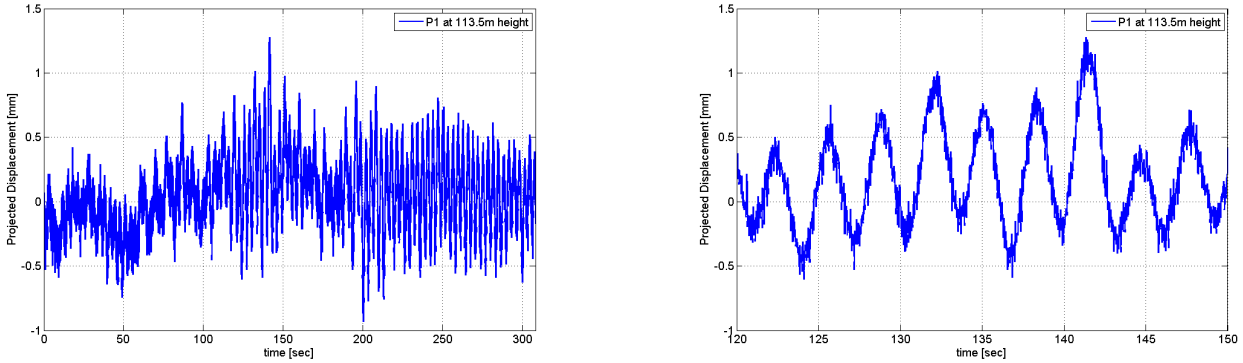

Fig. 4: Measurement point at 113.5 m height displacement. Entire measure (left), 30sec measure (right)

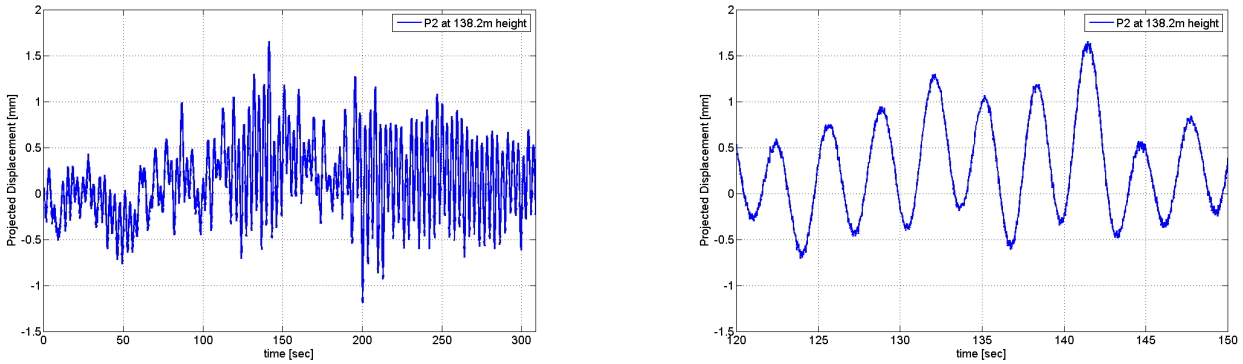

Fig. 5: Measurement point at 138.5 m height displacement. Entire measure (left), 30sec measure (right)

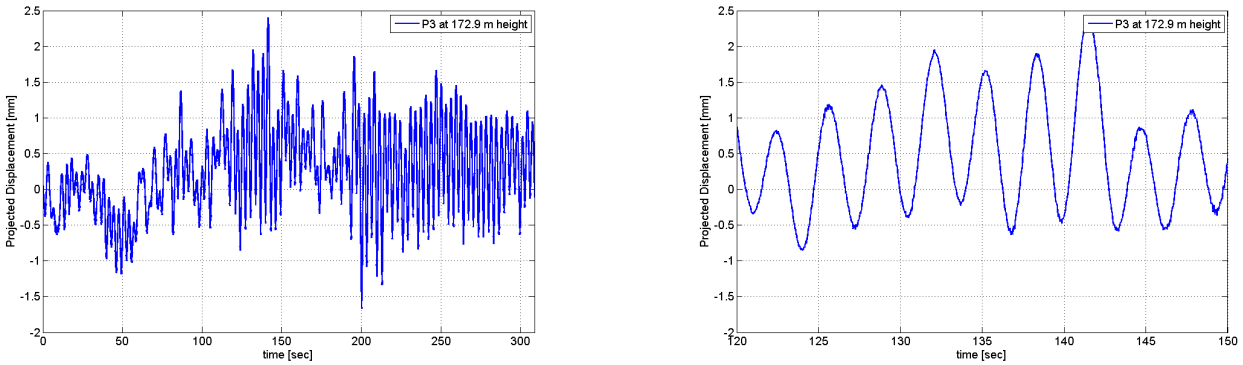

Fig. 6: Measurement point at 172.9 m height displacement. Entire measure (left), 30sec measure (right)

By the observation of the previous images it is possible to infer the good quality of the displacement signal even at far distances.

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Results – Frequency and modal analysis

Results of data processing in terms of extracting the resonance frequencies of the chimney are shown in the following figure showing the frequency spectrum of the structure derived from IBIS-S data.

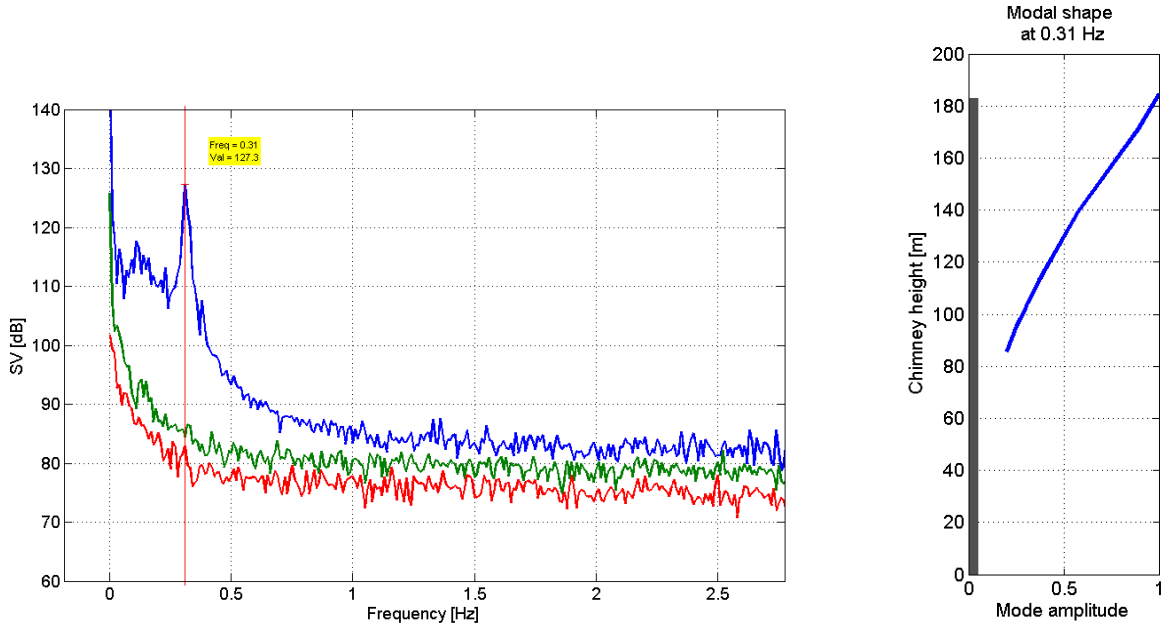

Fig. 7: Frequency analysis using FDD method

Analysis of the data acquired by IBIS-S permits to identify the resonance frequency of the chimney, equal to 0.31Hz, and the corresponding modal shape.

Conclusions

This case study highlights the possibility to use IBIS-S as instrument to perform dynamic tests of vertical structures, such as chimneys, in order to identify structure behaviour under dynamic stress without the need to access the structure to install sensor or optical targets.

IBIS-S has measured, from a remote site, at the same time the displacement of several points belonging to the chimney body with an accuracy of 0.02mm. The dynamic analysis of the displacement data has lead to the identification of the resonance frequency and of the related modal shape.

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